TOPOGRAPHIC ANALYSIS OF EARLY CHANGES IN CORNEAL ASTIGMATISM AFTER MANUAL SMALL INCISION CATARACT SURGERY WITHOUT SUTURE AND WITH SINGLE RADIAL SUTURE USING COMPUTERIZED VIDEOKERATOGRAPHY

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CERTIFICATE

This is to certify that **Dr. VIDHYA. S, M.S.,** Post Graduate student in Ophthalmology, Regional Institute of Ophthalmology, Govt. Ophthalmic Hospital, attached to Chennai Medical College, Chennai, carried out this Dissertation titled, **"TOPOGRAPHIC ANALYSIS OF EARLY CHANGES IN CORNEAL ASTIGMATISM AFTER MANUAL SMALL INCISION CATARACT SURGERY WITHOUT SUTURE AND WITH SINGLE RADIAL SUTURE USING COMPUTERIZED VIDEOKERATOGRAPHY"** by herself under my guidance and direct supervision, during the period, July 2003 – September 2006. This dissertation is submitted to the Tamil Nadu Dr. MGR Medical University, Chennai in partial fulfillment of the award of M.S. Degree in Ophthalmology**.**

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CONTENTS

INTRODUCTION

With better resolution of operating microscope, finer suture materials and revised surgical techniques, the elusive goal of cataract surgeons is towards **the ideal astigmatism neutral cataract surgery**.

Charles. D. Kelman, the pioneer in phaco surgery has written in one of his books, **"Those of us who perform the technique become enamored of the procedure, elated by the white quiet postoperative eyes, proud of the work as an artist is proud of his and empathetic with the patients who back at work the next day proclaims that he had a cataract removed the day before and has no physical limitations".**

Cataract forms the second most prevalent treatable cause of blindness in the world today. No surgical specialty has been dominated by a single surgery as ophthalmology has by cataract extraction.

Cataract surgery is the most frequently performed operation in patients over 65 years of age. A technological explosion has arrived in the techniques of cataract extraction & in the optical correction of aphakia.

The results of cataract surgery are evaluated by **the "objective criteria"**- to produce a limbal or corneoscleral tunnel incision which heals securely with or without suture without any undue sclerosis. Cornea should be clear without any distortion. Vitreous, retina, choroid, sclera and structures posterior to orbital fascia should not be disturbed.

"The subjective criteria" is to achieve 6/6 vision for majority of patients with good stereoscopic wide field of vision. Both above criteria must be met satisfactorily.

CONTROL OF POST OPERATIVE ASTIGMATISM

Corneal astigmatism has been a byproduct of cataract surgery since the first limbal incision was made. In most instances it was found that, a characteristic with the rule or against the rule astigmatism was induced by particular technique.

Factors Governing the Type of Astigmatism are:-

1. **Wound compression** – caused by deeply inserted sutures, wide suture bites, tightly tied sutures, greater number of sutures.

2. **Wound gape** – caused by opposite of these factors. In most studies, it was found that **limbal incision closed with modern non absorbable sutures tends to cause a steepening of cornea in the meridian that intersects the incision i.e. with the wound astigmatism. Sclero- corneal tunnel incision** as used nowadays in small incision cataract surgery & phacoemulsification wound **tends to produce against the wound astigmatism.**

HISTORICAL REVIEW OF CATARACT SURGERY

History of cataract surgery dates back to 1000 B.C. when “Susrutha”, a famous Hindu surgeon practised “couching”.

HISTORY OF EVOLUTION OF CATARACT SURGERY

Calendar of events in the evolution of cataract surgery

- 1000 BC- Susrutha – practised couching.
- 280 BC – Hemophilus & Philoxenes – practised cataract surgery in Alexandrian school.
- 1665 AD – Stephen Blankart – removed cataractous lens through a corneal incision.
- 1707 Charles Saint Yves – delivered an opaque lens after its accidental anterior dislocation during couching.
- 1736- Benedict Duddel- extracted soft cataract by inserting a lancet concealed in a cannula through the lens capsule.
- 1748 **Daviel – demonstrated the first successful cataract extraction in front of Royal College of Surgeons. The fine maneuvers formulated by Daviel & his successors remain the main steps of operation till now.**
- 1752 – George de La Faye – devised a single knife to make corneal incision and a cystitome to incise the anterior capsule.

- 1770 – Pierre Francis Benezeta Pamard – advised the patient to lie on his back instead of seated and made an incision in the upper part of cornea.
- 1773 - Sharp – advocated intracapsular extraction by using thumb-pressure after corneal incision.
- 1801 – Carl Himley Gottinzen- introduced mydriasis before cataract extraction.
- 1862 – Albert Mooren – advocated preliminary iridectomy.
- 1863 – Julius Jacobson – introduced a limbal incision.
- 1867 – Henry William – introduced corneoscleral sutures.
- 1870 – Terson – extracted the lens by traction with a toothed forceps.
- 1884 – Karl Kollar – introduced local analgesia by instillation of cocaine drops on cornea.
- 1902 – Stoever – devised a suction apparatus & cup to extract the lens by pneumatic traction.
- 1917 – Barraquer – developed erisophake controlled by an electric pump
- 1919 – Williard
- 1920 – Van lint
- 1926 – Wright
- 1929 – O'Brien-

All brought about improvements in regional anesthesia and akinesia.

- 1928 – Elsching – suggested retrobulbar injection for akinesia & superior rectus bridle suture.
- 1930 – Arruga -devised eye speculum for proper exposure.
- **1933 – Stallard – advocated corneoscleral suturing**.
- **1949-Harold Ridley- devised posterior chamber intraocular lens**.
- 1951 – Dunnigton- advocated abexterno incision and limbus based conjunctival flap.
- 1954 – Strampelly- devised the anterior chamber intra ocular lens.
- 1959 – Barraquer – introduced the use of chymotryprin zonulolysis.
- 1961 – Krawitiz – devised the cryoextractor.
- **1968 –Charles Kelman- developed the phakoemulsifier.**

SELF SEALING CATARACT INCISIONS - HISTORICAL MILESTONES

Kratz was credited as the first surgeon to move from limbus posteriorly to sclera, increasing appositional surface thereby controlling surgically induced astigmatism.

Girard and Hoffman were the first to call the posterior incision **“Scleral Tunnel Incision”.**

Shephard introduced the single horizontal suture for the closure of 4mm scleral tunnel incision in phacoemulsification and foldable lens implantation.

Mc Farland and Ernest introduced the first **"No stitch incision"**. This incision with posterior lip, the so called 'Corneal lip' acted as a **One Way Valve** imparting its **self sealing character**.

Paul Koch introduced the **"Incision Funnel".** He indicated that self sealing incision with respect to length and configuration, imparted not only sealability, but also astigmatism neutrality to these incisions.

CORNEA AS A REFRACTIVE MEDIUM

Anatomy of the cornea:

The transparent cornea is the main structure responsible for the refraction of light entering the eye.

The clear transparent cornea forms the anterior one sixth of the eyeball. Because its curvature is greater than over the rest of the eyeball, a slight sulcus, the sulcus sclera, marks the junction of cornea with the sclera.

Although the dimensions of the cornea vary considerably from one person to another, the approximate measurements are about 10.6mm vertically and about 11.7mm horizontally being elliptical from front. From behind, the cornea is concave and circular measuring about 11.7mm in diameter. The cornea is thinnest at its center, measuring about 0.5 to 0.6mm and thicker at the periphery measuring about 0.7mm.

The radius of curvature of anterior surface is about 7.7mm and that of posterior surface is 6.9 mm. However it should be pointed out that it is frequently more curved in the vertical than in horizontal planes (Regular astigmatism). Anatomically the cornea can be divided into cornea proper and the limbus.

THE CORNEA PROPER:

The cornea proper is comprised of six concentric layers,

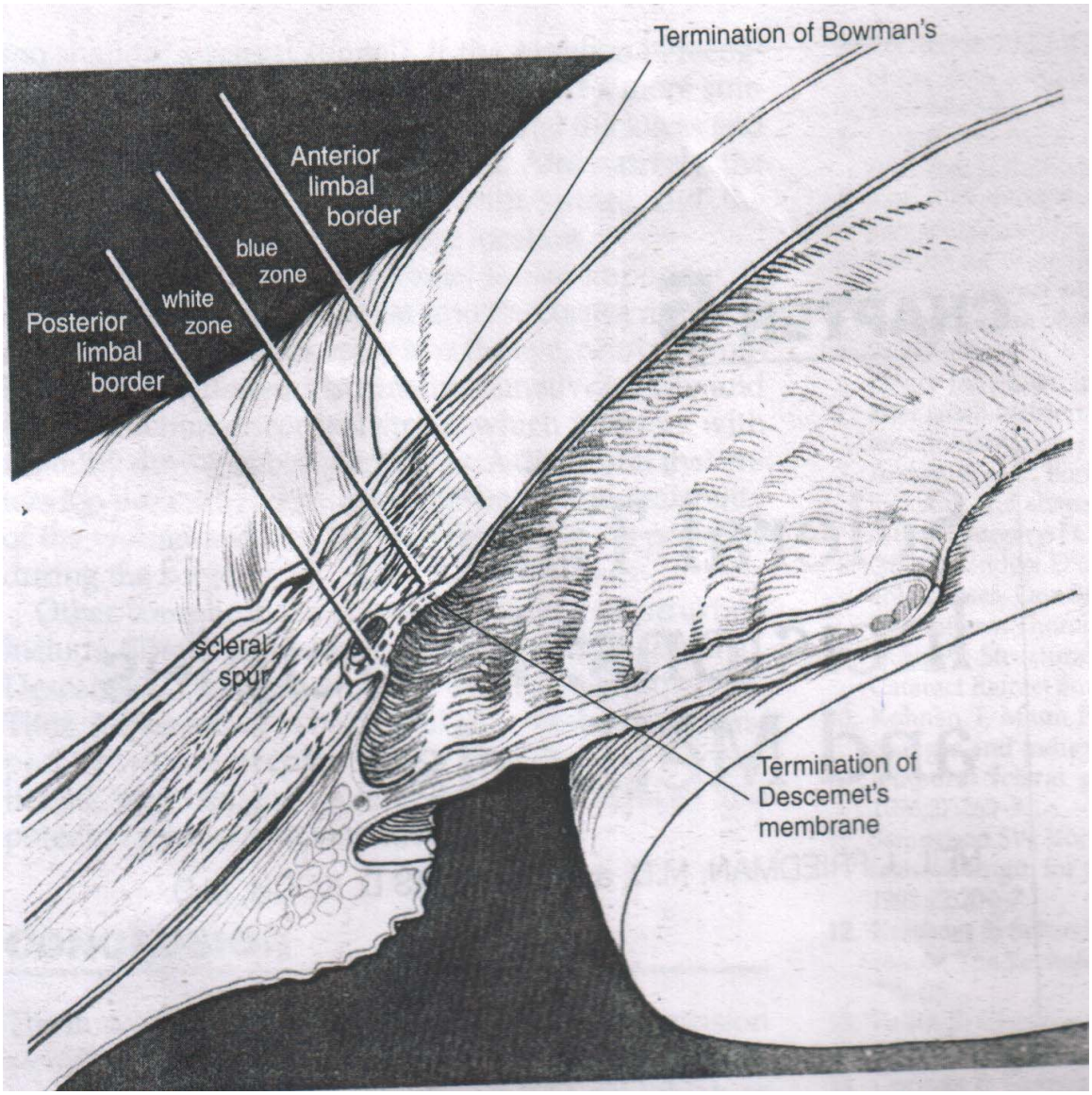
1. The epithelium,
2. The epithelial basement membrane,
3. The acellular Bowman's layer,
4. The corneal stroma,
5. Descemet's membrane and
6. The corneal endothelium.

Epithelium: The corneal epithelium is stratified and consists of five layers of cells. Its thickness measures about 50 to 60µm. The superficial cells are nonkeratinized squamous cells and the deep cells are columnar. At the corneoscleral junction (limbus), the epithelium becomes thicker and may consist of 10 or more layer of cells.

Bowman's Layer: Bowman's layer measures 8 to 12µm in thickness. It is acellular consisting of interwoven collagen fibrils embedded in intercellular substances.

Stroma: This forms about 90 percent of corneal thickness. It consists of lamellae of collagen fibrils that run parallel with the surface. It is transparent, fibrous and compact.

ANATOMY OF THE SURGICAL LIMBUS



Descemet's membrane: This membrane is strong and homogenous, composed of type IV collagen fibrils arranged in hexagonal pattern.

Endothelium: The corneal endothelium consists of a single layer of flattened cells that are polygonal in shape.

THE LIMBUS:

The limbus is the transition zone between the conjunctiva and sclera on one side and the cornea on the other side. It appears as a grey transparent area with a fairly well defined corneal edge and merges inconspicuously into the sclera.

Histologically limbus differs from cornea proper. Here bowman's membrane stops short in a rounded edge and descemets membrane tapers to a point. Therefore only two layers are present, epithelium and stroma. Moreover, it is characterized by the presence of blood vessels and lymphatics which are absent from cornea proper.

Surgical anatomy of limbus:

The **limbus (Corneoscleral junction)** is an important landmark for the ophthalmologist.

Kasner has likened the surgical anatomy of the limbus to **Tennis Court**. The junction of the blue and white area is the net overlying schwalbe's line.

The anterior baseline (bump) overlies the termination of bowman's membrane which is the anterior border of the limbus. The posterior baseline overlies the scleral spur or root of the iris which is the posterior border of the limbus.

The **surgical limbus** is defined by the beginning of the bluish area marking the transition zone between the cornea and the sclera. The **anatomical limbus** is defined by schwalbe's line. The surgical limbus is located slightly anterior to the anatomical limbus.

Having reflected the conjunctiva, the posterior border of the surgical limbus can be identified between the transparent bluish cornea and the opaque white sclera. Thus the blue portion of the limbus overlies the clear cornea whereas the white portion overlies the trabecular meshwork. The junction of blue and white area overlies the end of descemet's membrane or schwalbe's line.

An incision along the posterior border will pass in front of the canal of schlemm and the anterior part of the trabecular meshwork. An incision made at the junction of corneal and conjunctival epithelium enters the anterior chamber of the eye anterior to the trabecular meshwork.

IMPORTANT MEASUREMENTS OF THE HUMAN CORNEA AS REFRACTIVE MEDIA

THICKNESS

Peripheral 700 µm

Central 540 µm

REFRACTIVE INDEX

Air 1.00

Tear 1.336

Cornea 1.376

Aqueous 1.336

Radius of curvature

Anterior 7.7 mm

Posterior 6.9 mm

Central radius of curvature and refractive power

Air – tear 7.7mm = +43.6D

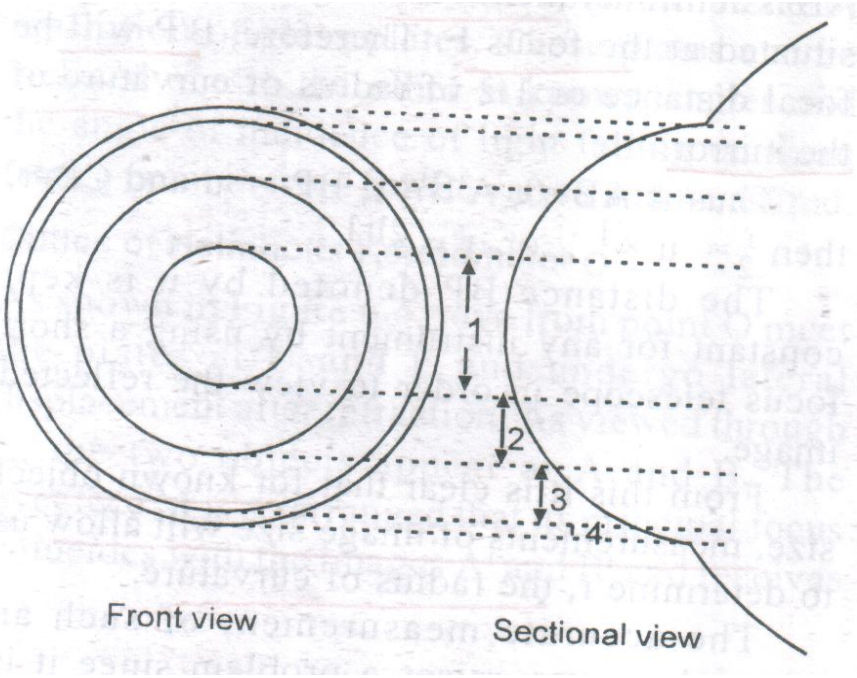
Tear-Cornea 7.7mm = +5.3D

Cornea -Aqueous 6.9mm = -5.8D

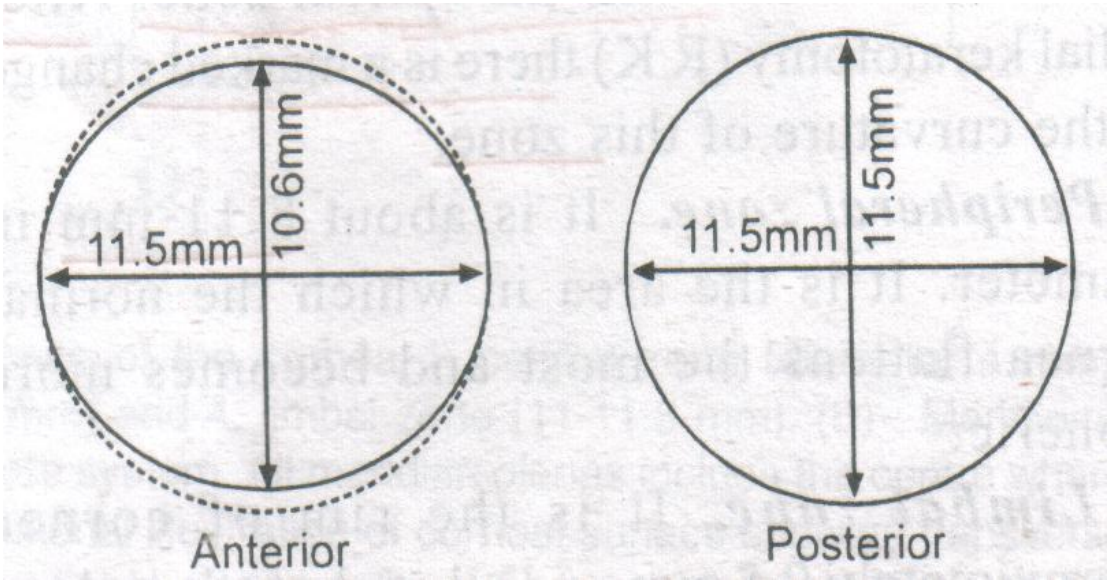
Total Central Refractive power = 43.1D

OPTICAL ZONES OF CORNEA

1. Central Zone (diameter 4 mm), 2. Paracentral Zone (between 4-8 mm) 3. Peripheral Zone (8-11 mm) and 4. Limbal Zone (11-11.5 mm).



VERTICAL AND HORIZONTAL DIAMETER OF THE ANTERIOR AND POSTERIOR SURFACE OF CORNEA



OPTICS OF THE CORNEA

Refraction takes place significantly at only three of the four surfaces. This is because the substance of the cornea has a refractive index practically the same as that of aqueous. Also the refractive indices of aqueous and vitreous are almost the same.

The light entering the eye is refracted markedly at the anterior corneal surface because its central spherical part has a radius of curvature of about 7.8mm and also because of the big difference in refractive indices of air (1.00) and cornea (1.37). The light then undergoes little further refraction till it reaches the lens. At both surfaces of lens, it is refracted. While the refractive index of the substance of the lens is higher than that of aqueous and vitreous, the difference is not so marked as between that of cornea and air.

Thus the major part of the ocular refraction takes place at the anterior corneal surface, the optical power of which (40 to 45D) is twice that of the lens (18 to 20D).

Cornea acts like a weak concave lens as the curvature of its posterior surface **(6.9mm)** is little greater than that of anterior surface **(7.7mm).** But **in the eye, it acts like a very powerful converging lens** as the aqueous has a refractive index differing only slightly from that of the corneal substance. The average anterior corneal surface has nearly 49D of convergence; posterior surface has

nearly 6D of divergence, making the net refractive power of the cornea to about 43D of convergence.

Anterior corneal curvature – A Prolate

The anterior corneal surface is not exactly spherical since the peripheral part is substantially flatter than the central part. The central part has an average curvature of 7.8mm. The optical zone is nearly spherical but keratometry shows that even in this region curvature varies in different meridians, proving the **apical zone to be toric**. Hence the refractive system of the eye has some **built-in physiological astigmatism.** It is very difficult to define the size of the **Central Optical Zone** and to determine where exactly the optical zone ends and the peripheral zone begins. The ideal criterion defines the central optical zone, as that amount of central area varying in power not more than 1D difference. The average value is about **4mm**.

Astigmatism:

Astigmatism is that condition of refraction wherein a point focus of light cannot be formed upon the retina.

Theoretically no eye is stigmatic and in practice we include under the form of ametropia those anomalies in the optical mechanism wherein an appreciable error is caused by the unequal refraction of light in different meridians**.**

AETIOLOGY:

Astigmatism may be an error either of curvature, of centering or of refractive index.

Curvature astigmatism if any high degree has its seat most frequently in the cornea. The anomaly is usually congenital. Its occurrence in small degree is almost universal. The most common error is one of about **0.25D**, wherein the vertical curvature is greater than that of horizontal. This is known as **with the rule astigmatism** and is considered **physiological**. It is presumably due to the **constant pressure of the upper lid on the cornea**.

Whereas at birth, cornea is nearly spherical, this type of astigmatism is present in 68% of children at 4 years, and 95% at 7 years. It tends to increase to a very slight extent with advancing years.

At old age eye it tends to disappear or even reverses itself into "Against the rule" type with the vertical curvature less than horizontal.

In acquired astigmatism, diseases of cornea result in its deformity. Traumatic interference with the cornea may bring about the same results and in this category we must include surgical trauma particularly that of cataract surgery. Corneal astigmatism can also be induced by the pressure of lid swellings, e.g. chalazion, neoplasms etc, also transiently by the forced action of extra ocular muscles.

Curvature astigmatism due to lenticonus, subluxated decentered lens etc. lead to similar results.

“Index astigmatism” usually occurs as a result of uneven increase or decrease in the refractive indices of the optical media mainly that of the lens, e.g. early cataract.

OPTICAL CONDITIONS IN ASTIGMATISM:

In astigmatism, when parallel rays of light pass through the optical media, there forms **Sturm’s Conoid,** with two focal lines instead of a single focal point, separated by a focal interval. The circle of least confusion is located dioptrically midway between two focal lines. The length of the focal interval is the measure of the magnitude of astigmatism. This can be corrected by reducing these two focal lines into a single focal point onto the retina.

TYPES OF CORNEAL ASTIGMATISM:

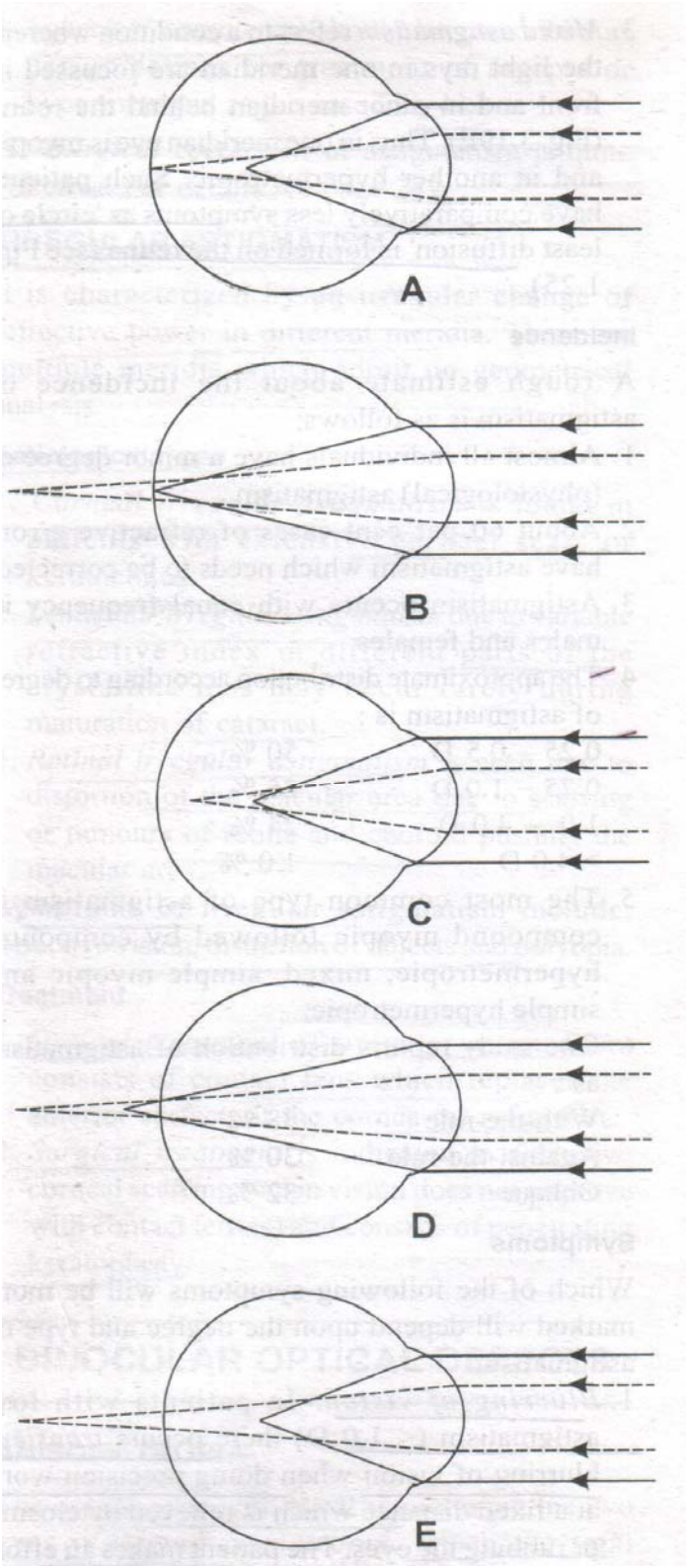
A). Regular astigmatism: The principal two meridians are at right angles to each other.

i) Astigmatism with-the rule: Vertical meridian has the greatest curvature.

ii) Astigmatism against-the-rule: Horizontal meridian has the greatest curvature.

REFRACTIVE TYPES OF REGULAR ASTIGMATISM
A – SIMPLE MYOPIC, B – SIMPLE HYPERMETROPIC, C- COMPOUND MYOPIC,

D – COMPOUND HYPERMETROPIC AND E – MIXED



iii) Oblique regular astigmatism: The principal meridians are neither vertical nor horizontal but they are at right angles to each other.

b). Bi-Oblique Astigmatism: The principal meridians are neither vertical nor horizontal nor are they at right angles to each other.

c). Simple astigmatism: One of the focal lines falls on the retina. The other may fall either in front of the retina as in “ simple myopic astigmatism”, or behind the retina as in “ simple hypermetropic astigmatism”.

d). Compound astigmatism: Neither of the two focal lines falls on the retina, but are placed either in front of the retina as in “compound myopic astigmatism”, or behind the retina as in “compound hypermetropic astigmatism”.

e). Mixed astigmatism: One of the focal lines falls in front of the retina and other focal line behind the retina.

f). Irregular astigmatism: Irregularities in the curvature of the cornea in different meridians is such that no geometrical pattern is adhered to.

EVALUATION OF CORNEAL ASTIGMATISM

KERATOMETERS, KERATOMETRY & VIDEO KERATOSCOPY

CORNEAL TOPOGRAPHY

It is the study of curvature and refractive status of the anterior corneal surface.

EVOLUTION OF KERATOSCOPY

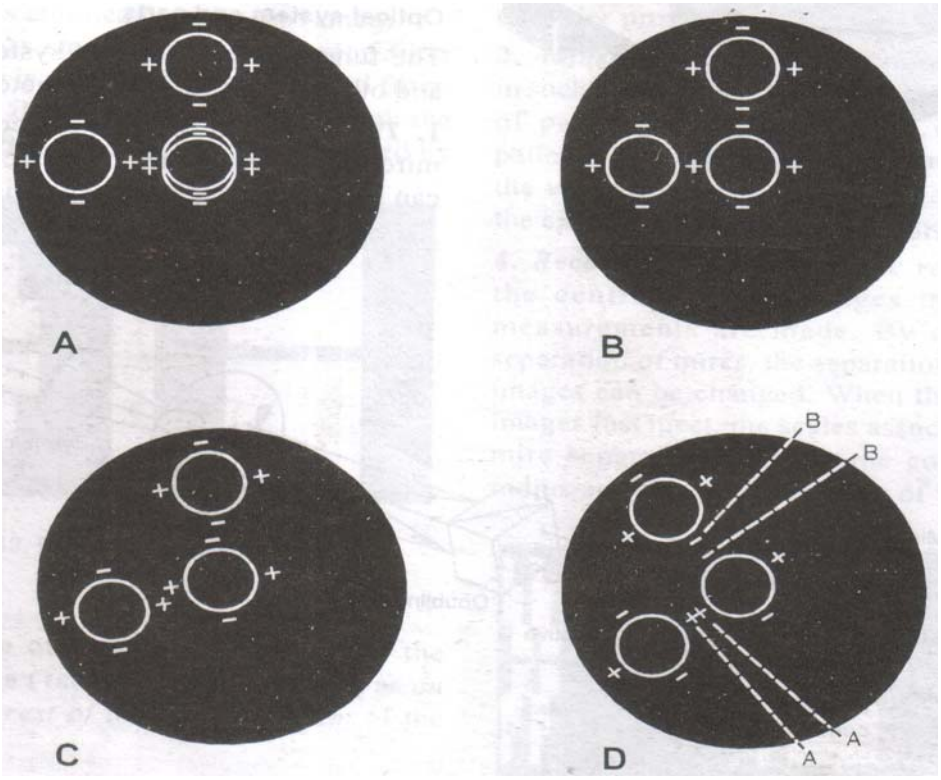
- Evaluation of corneal curvature was first attempted by Christopher Sheiner, a priest.
- He compared images of windows reflected by cornea to images reflected by marble balls of known diameter.

KERATOMETRY

Helmholtz devised an instrument named ophthalmometer to measure the curvature of cornea. Later the term KERATOMETER was preferred over ophthalmometer.

It provides quantitative information. Yet it measures the radius of curvature of corneal ring of diameter only 3-4 mm.

EXAMINER'S VIEW OF THE MIRES: A – AFTER ALIGNMENT, B – MEASURING HORIZONTAL MERIDIAN, C – IN OBLIQUE ASTIGMATISM AND D- ALIGNMENT OF PLUS SIGNS IN OBLIQUE ASTIGMATISM



BAUSCH AND LOMB KERATOMETER

No information regarding corneal surface central & peripheral to these points are obtained.

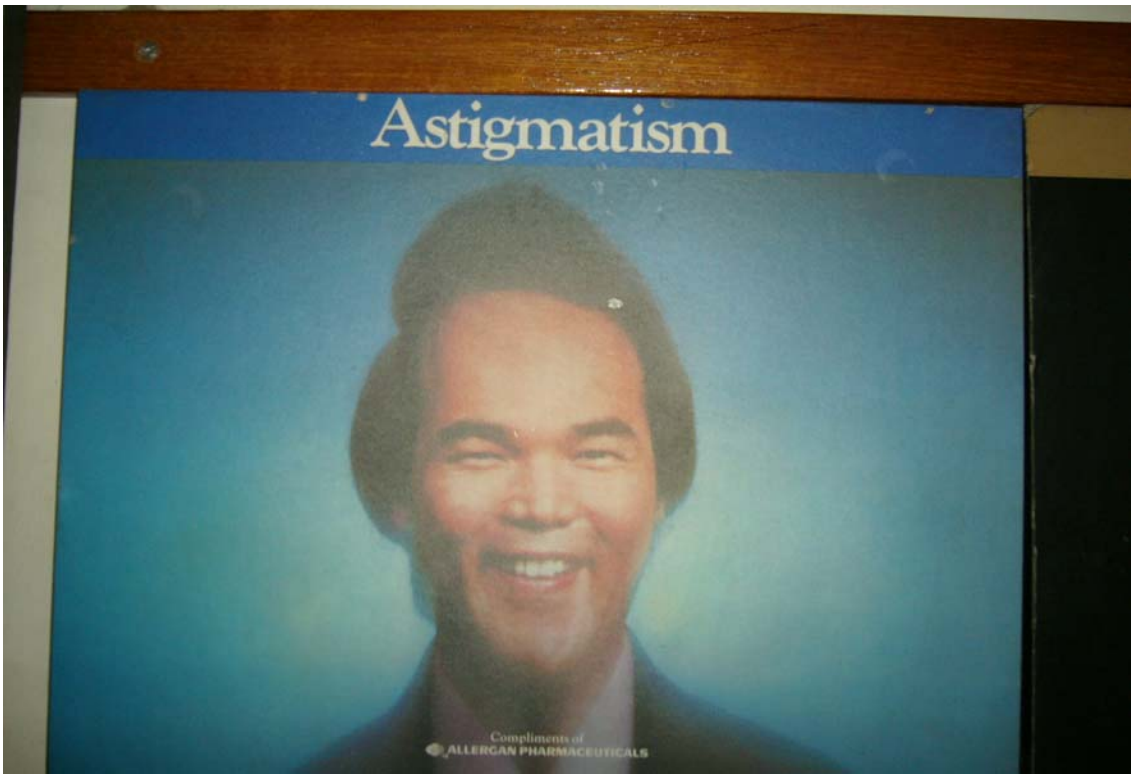
Optical Principle:

The corneal surface with extremely thin film of tear fluid acts as a polished convex mirror and thus a reflected image is formed of any luminous object placed in front of the eye. The size of the image depends on the size of the object, the distance of the object from the cornea and the radius of curvature of the cornea. In a keratometer the distance of the object from the eye under observation is fixed. Therefore, by varying either the image or the object size, the radius of curvature can be calculated.

Types of Keratometers:

1. Bausch & Lomb keratometer:

A target or mire of known size is placed at a known distance from the corneal surface. The size of the virtual image is measured using calibrated doubling device in a short focus. The virtual image becomes an object for the measuring device and a real inverted image is formed within the instrument. The image so formed is measured by a doubling device incorporated in the instrument.



PLACIDO DISC

Horizontal Meridian:

The instrument is adjusted back & forth if there is any doubling of the plus mires. Now horizontal drum is moved clockwise or anticlockwise to superimpose the two plus mires into a single plus sign.

Vertical Meridian:

The two minus sign are superimposed by rotating the vertical drum. **The advantage** of the instrument is that once focused both the meridians can be measured simultaneously.

Other types of keratometers used are:

2. Helmholtz ophthalmometer

3. Haag – Streit keratometer

4. Javal – Schiotz keratometer etc..

KERATOSCOPY

•Refers to study of topography of corneal surface by direct observation of images of mires reflected from the surface of cornea.

Placido disc keratoscopy

•Developed by Antonio Placido, 1880.

•It consists of equally spaced alternating black & white rings, with a 3D positive lens inserted in a central hole which permitted focusing at about 30cm.

- In Spherical cornea - circular rings are seen.
- In Astigmatism – elliptical rings are seen.
- In Steeper cornea – thinner and closer rings are formed.
- In Irregular cornea - distorted and irregular rings are seen.
- It gives only qualitative, no quantitative information.

PHOTO KERATOSCOPY:

- Gullstrand devised photokeratoscope in 1880.
- It provides quantitative information.
- The image of most photokeratoscope rings covers the paracentral area but leaves the optically important central 3mm as well as peripheral cornea.
- Corneal cylinders up to 3D can escape detection.

VIDEO KERATOSCOPY:

THE PRESENT DAY CORNEAL TOPOGRAPHY

- When the image is video recorded, it is called video keratoscopy.
- It is computerized & data points on the mires can be resolved automatically.

•COMPUTER ASSISTED VIDEO KERATOSCOPE is synonymous with CORNEAL TOPOGRAPHY.

•First computerized keratoscope was CORNEAL MODELING SYSTEM (CMS) followed by CORNEAL ANALYSIS SYSTEM (CAS).

•These systems are almost replaced by TOPOGRAPHIC MODELING SYSTEM (TMS).

TOPOGRAPHIC MODELING SYSTEM IN DETAIL

• It is based on the old principle of Placido's disc.

•It incorporates many luminous concentric rings.

•On each complete ring, 256 points are identified which give corneal reflections at 180µm intervals.

•It provides around 7000 data points in toto.

•It gives an accuracy of 0.10D.

•Two cones are used.

•25 Ring cone is for standard used. It covers 8.5mm of cornea

•31 Ring cone projects rings farther peripherally, which covers 11mm diameter of cornea. This cone is recommended for contact lens fit.

TOPOGRAPHIC MODELING SYSTEM, TMS, TOMEY

DISPLAY OF TOPOGRAPHIC DATA

- Data can be displayed in 4 different formats.
- Topographic map
- Fourier map
- Numeric map
- 3-D map

TOPOGRAPHIC MAP

- The refractive power and radius of curvature of cornea are displayed in colour scales
- Colour coded topographic maps attributes a meaning to different colours.
- Cold colours – blue, black, azure indicate flatter surface.
- Warm colours– orange, red, white indicate steeper surface.
- Green & Yellow colours – represent curvatures & power found in normal eyes.

3-D MAP

- 3-D Map adds height of corneal shape to its two dimensional corneal display.
- It is useful when making explanation to patient.

NUMERIC MAP

- Numerical values as dioptres are displayed along the 25 meridians in the map.

FOUR TYPES OF MAP

- Standard
- Refractive
- Instantaneous
- Height

STANDARD MAP

- Displays the refractive powers in parallel.
- A spherical cornea without astigmatism is displayed in one colour in this map.

REFRACTIVE MAP

- Indicates refractive power by regarding cornea as lens.
- Good indicator of optical analysis.

INSTANTANEOUS MAP

- This map shows local slope of cornea.
- It is good indicator of keratoconus.
- It is used to intensify the border line between the portion cut out by PRK laser and its surrounding area.

TYPES OF SCALE

- Absolute scale
- Normalized scale
- Adjustable scale
- Klyce/Wilson scale
- Maguire/ Waring scale
- Custom scale

ABSOLUTE SCALE

- Developed by Stephen D klyce of university of Louisiana.
- Central part is divided into 11 parts with average 43 D at center.
- Each part has an interval of 1.5 D.
- Upper and lower parts are divided with an interval of 5 D.
- **Red colour, gradually becomes darker as curvature decreases.**
- **Blue colour becomes gradually darker as curvature increases.**

NORMALIZED SCALE

- Has 11equal intervals.
- The larger the difference between maximum and minimum refractive power, larger the colour range.
- Smaller the difference, smaller the colour range.

VIDEO FORMAT – VIDEO MIRES

•It is to verify quality of image taken.

INDICES

•Sim K – simulated keratometry : It gives average value of steepest meridian and its right angled meridian.

•Min K – very useful for arcuate keratotomy

•CYL – Simulated Keratometric cylinder

•SAI (surface asymmetry index)

•SRI (surface regularity index) influences potential visual acuity.

COLOUR CODED TOPOGRAPHIC MAP

It is very useful and commonly used.

INTERPRETATION:

•COLOUR CODES:

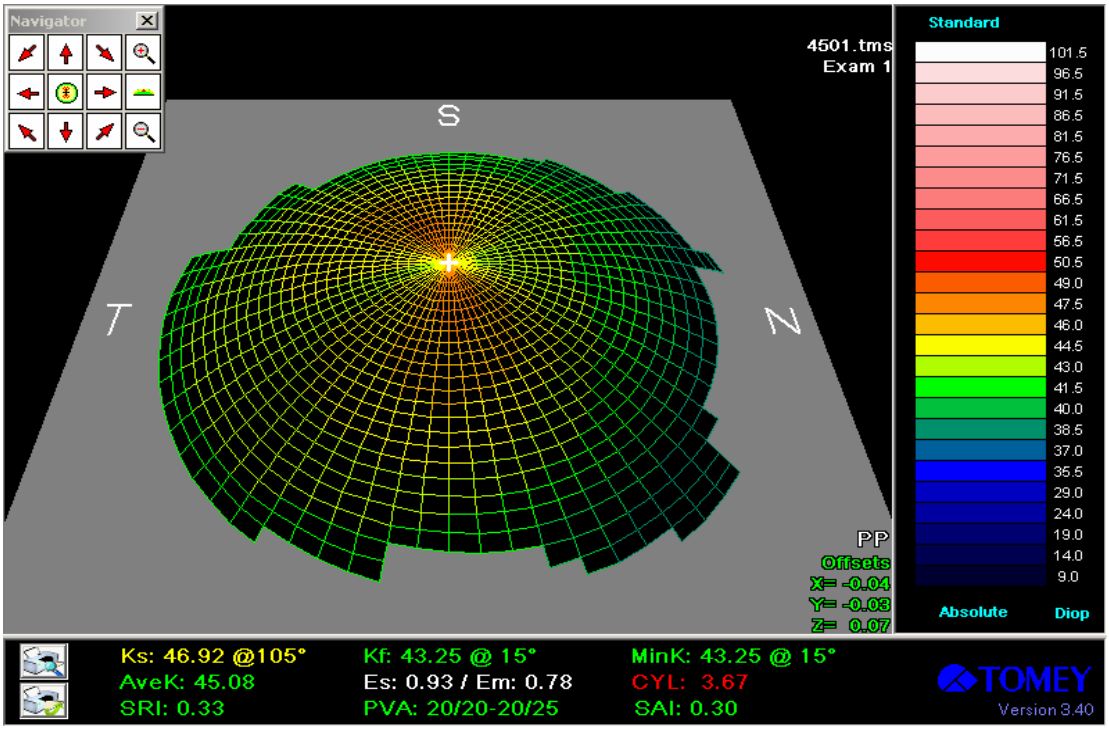
–Hot Colours: Red & its various hues represent the steep portions of cornea.

–Cool Colours: Blue & its various hues represent the flat portions of cornea.

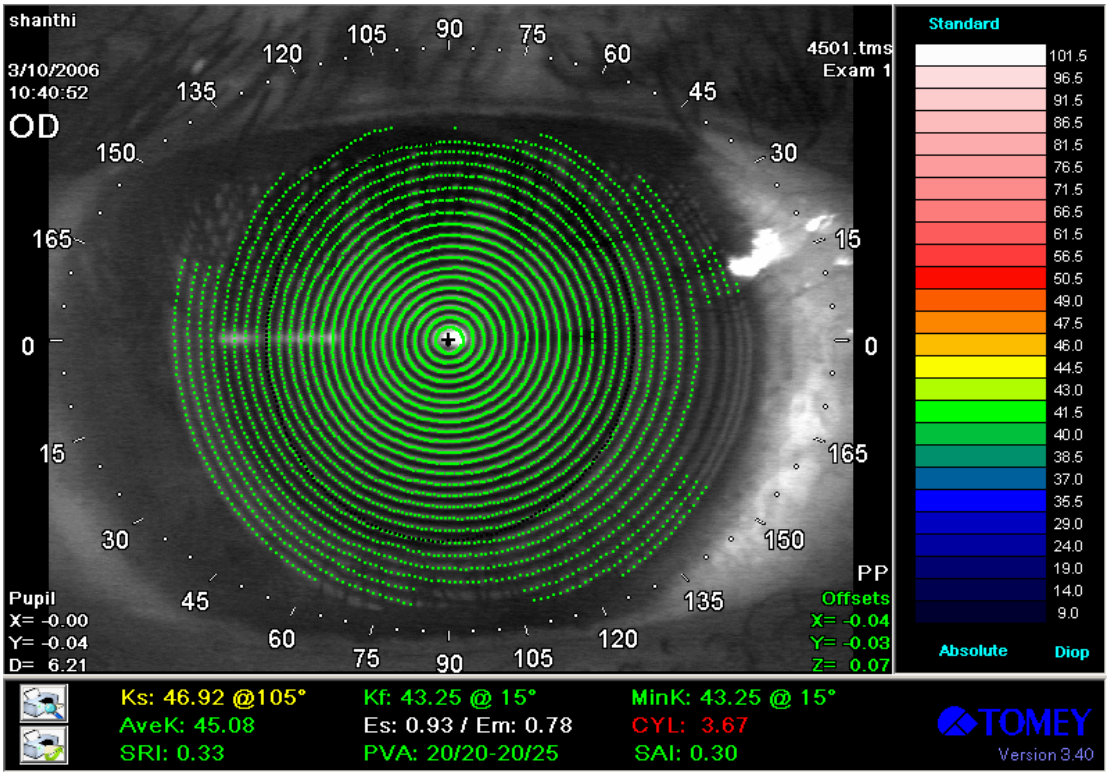
–So the colours, Red – Orange – Yellow – Green – Purple – Blue denote progressively lessening refractive power.

–Colour intensity is relative. E.g. 45D area is less red than 46D.

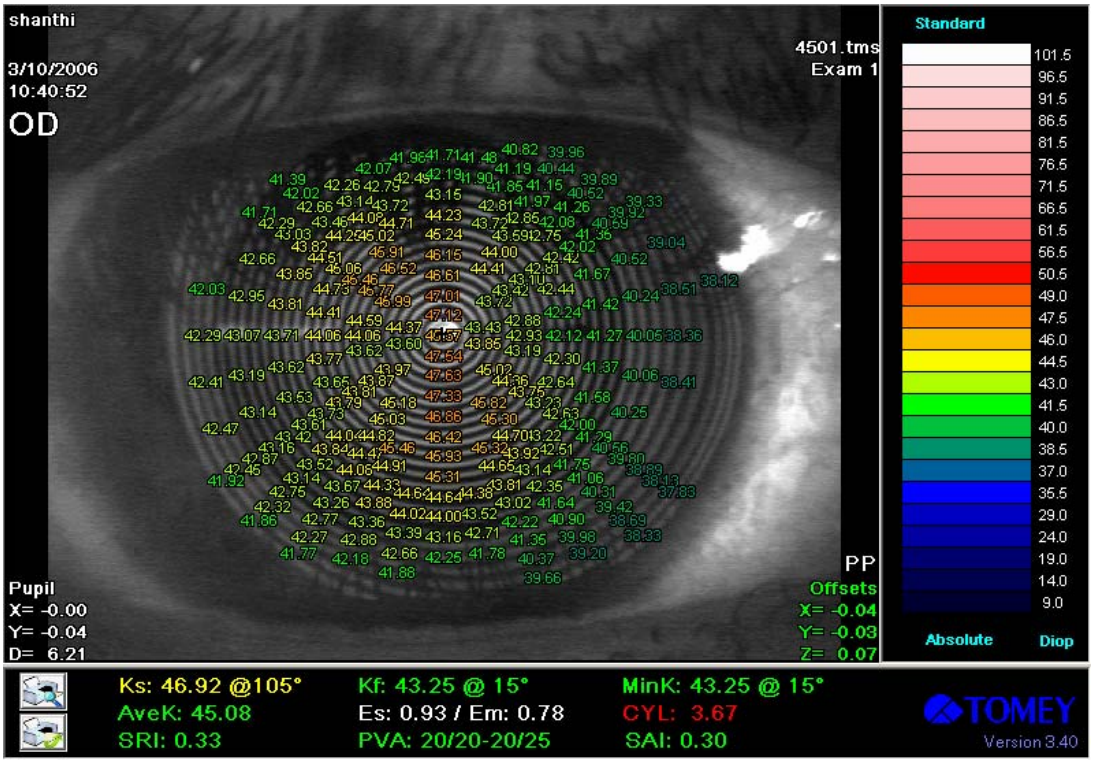
3D - MAP



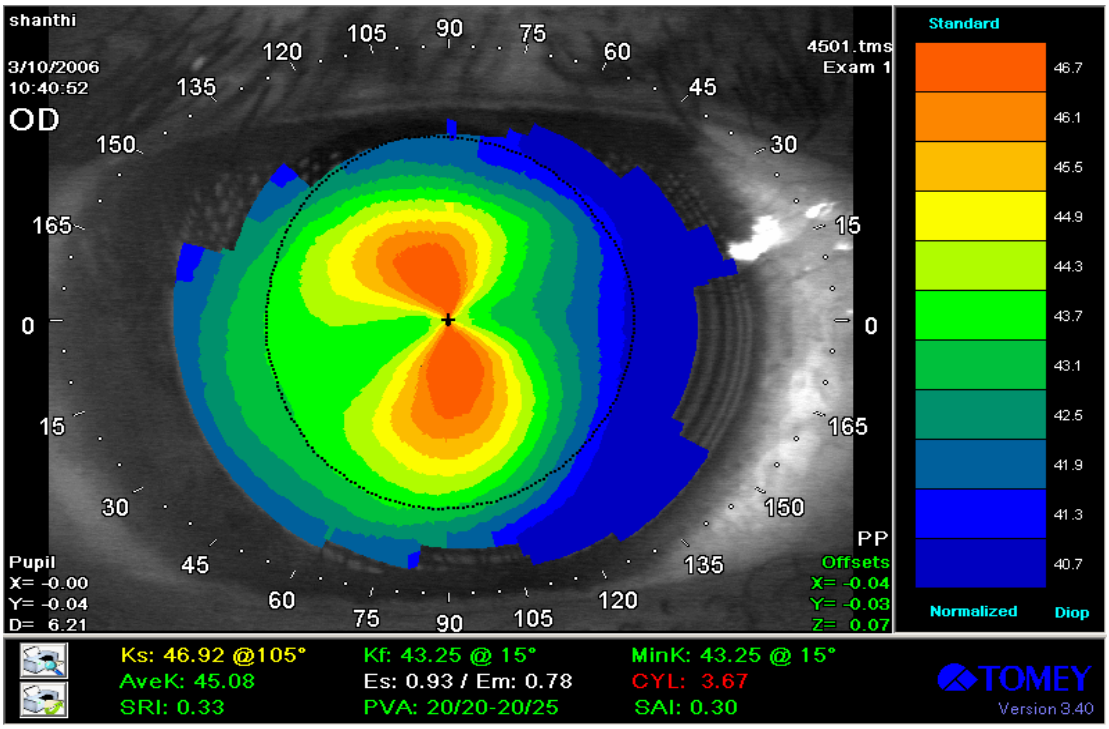
VIDEO MAP - TO VERIFY MIRES



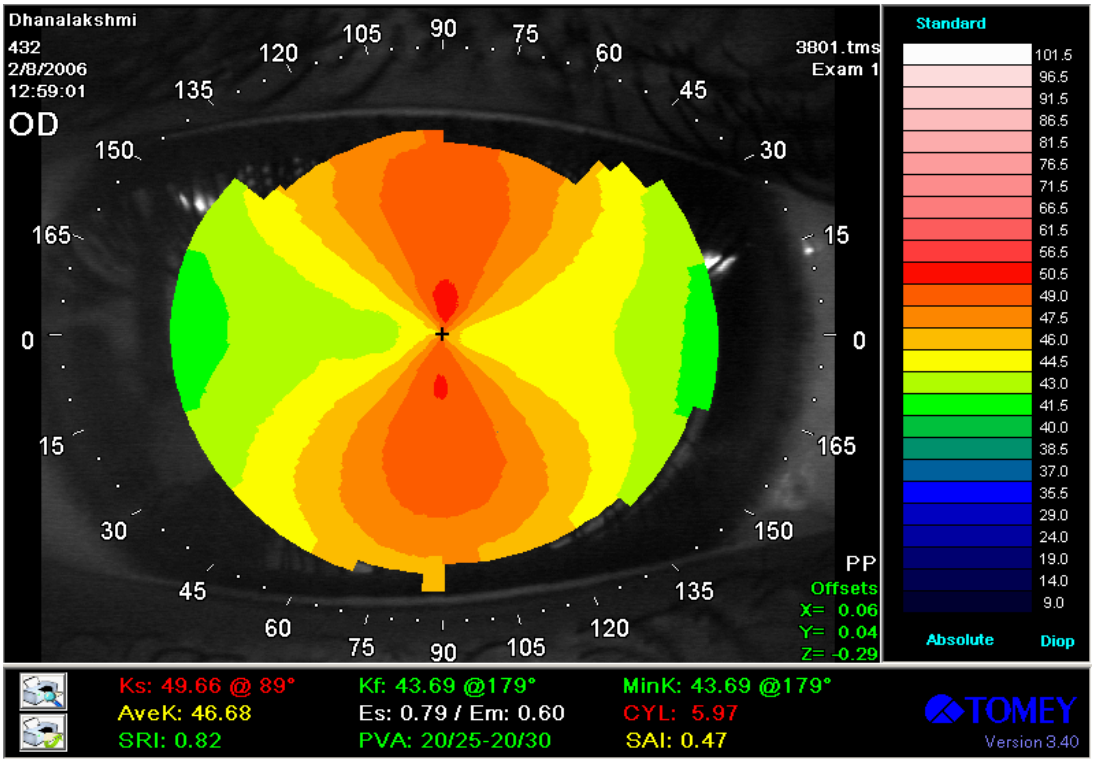
NUMERICAL MAP



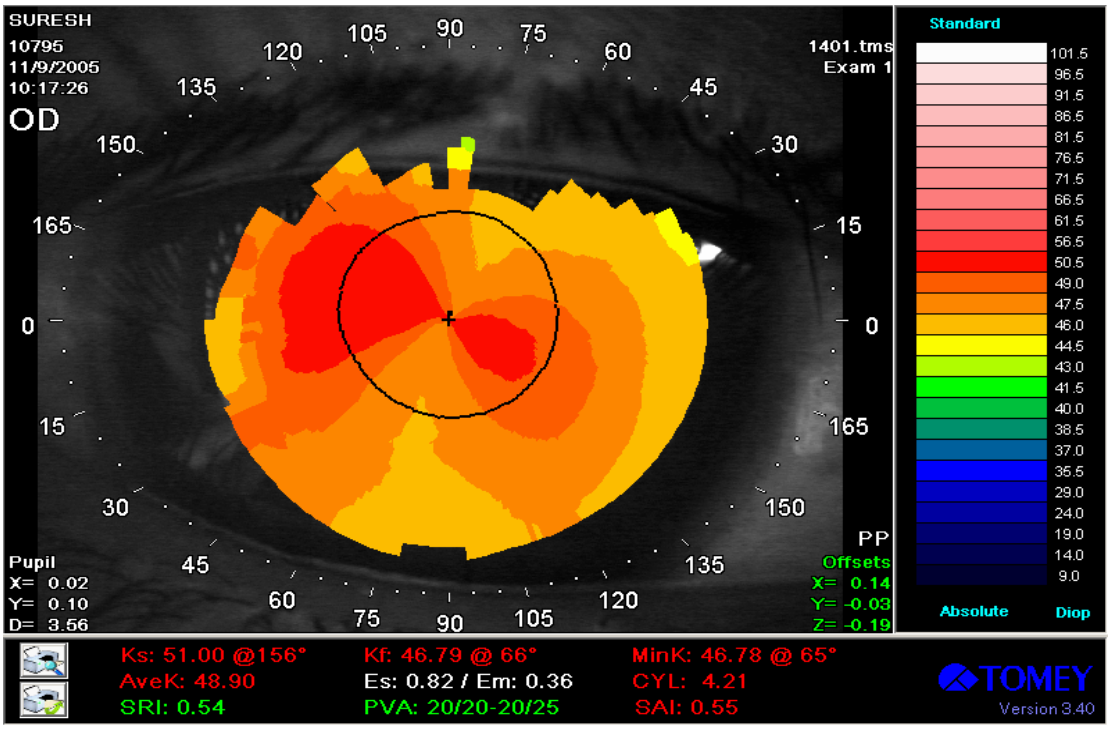
NORMALIZED SCALE MAP



SYMMETRICAL BOWTIE PATTERN



ASYMMETRICAL BOWTIE PATTERN



•Normal cornea shows aspheric prolate profile.

•Bogan & co-workers classified normal human corneas into 4 types

1. Round & Oval pattern – very low astigmatism.
2. Symmetric bow – tie pattern – symmetrical astigmatism.
3. Asymmetric bow – tie pattern– asymmetrical astigmatism.
4. Irregular pattern.

ASTIGMATISM

•Difference in curvature of the 2 principal meridians is displayed as bow – tie pattern

•Normal conditions –bow – tie is oriented along the steeper meridian.

•Size of the bow-tie indicates extent of the astigmatism change over corneal surface.

•Colour difference between the two principal meridians reflects the amount of astigmatism.

•To quantify the cylinder, all VKG system displays a simulated keratometry.

IRREGULAR ASTIGMATISM

•Corneal Topography varies depending on the pathology. Three patterns predominate

1. Semimeridional: the dioptric power of meridian is not equally distributed along the two semimeridians (e.g., keratoconus)

2. Oblique: the two principal meridians are not perpendicular (e.g., after keratoplasty)

3. Oblique-semimeridional: the two steeper or flatter semimeridians do not belong to the same meridian (e.g., pellucid marginal degeneration at an early stage)

FACTOR INFLUENCING THE POST OPERATIVE ASTIGMATISM

Corneal astigmatism has been a byproduct of cataract surgery since the first limbal incision was made.

With improved techniques and increased patient expectations, surgeons have been paying closer attention to the astigmatic effects of their operative procedures.

The cataract incision has undergone a metamorphosis since the early days of sutured incisions. **Length and Architecture of the incision, suture materials, suturing types** have all been examined and modified.

Work has accelerated in the last several years and this has led to the use of incisions that close with no sutures at all. Whether we have achieved the goal of controlling astigmatism remains to be seen.

CATARACT WOUND – EVOLUTION

1. Ab interno incision with von grafe knife.

This 180° wound was allowed to self seal initially with the patients head maintained in a fixed position. Later silk sutures were placed across the wound in varying numbers.

2. Single plane incision:

Straight entry incisions that directly enter the anterior chamber were introduced and closed with water tight deep radial suture bites. But patients had to wait 6-8 weeks to achieve clear vision to allow time for suture induced distortion to fade.

3. Multiplane incision – (self sealing incision)

Moving the small incision more posteriorly and creating a longer tunnel with a beveled entry wound into the anterior chamber present the self sealing effect. These incisions had better uncorrected vision, **quicker stabilization of refraction and quicker visual rehabilitation.**

3. **Clear corneal incision:**

Clear corneal incision under topical anesthesia has recently emerged as a favoured incision with phacoemulsification. Long term studies are needed to fully evaluate this technique yet.

SELF SEALING INCISION – COMPONENTS:

The External Incision

The Incisional Funnel

The Internal Incision

The external incision:

The traditional cataract incision is the curvilinear one which **follows the curve of limbus**. Such an incision always has a potential for **wound gaping and against the rule astigmatism.**

A straight incision has the two extremes of the incision secured in the sclera. It **reduces risk of wound gape and the potential for against the rule astigmatism.**

If the ends of the incision are placed even more superiorly on the sclera, a more stable frown shaped incision results.

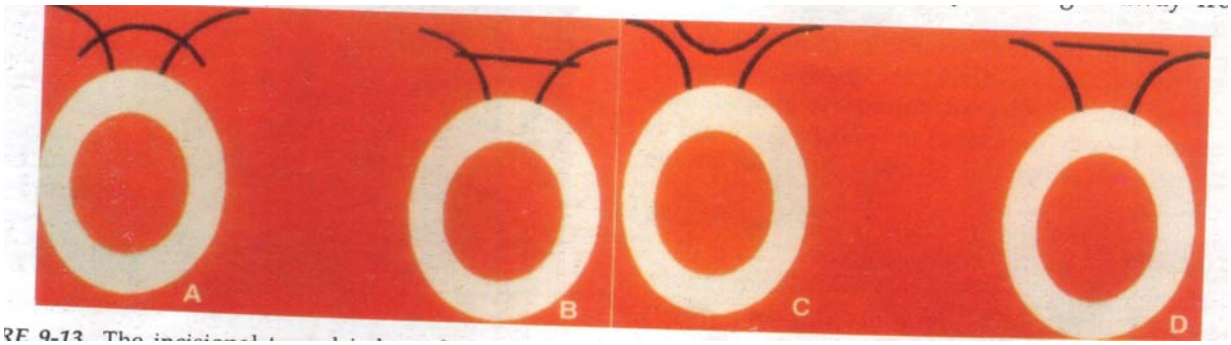
The Frown Incision has the **least potential for against the rule astigmatism and provides maximum stability of wound.**

A. A curvilinear incision parallel to the limbus crosses out the incisional tunnel and is unstable.

B.The straight incision placed at same distance still falls outside the tunnel but not by as much.

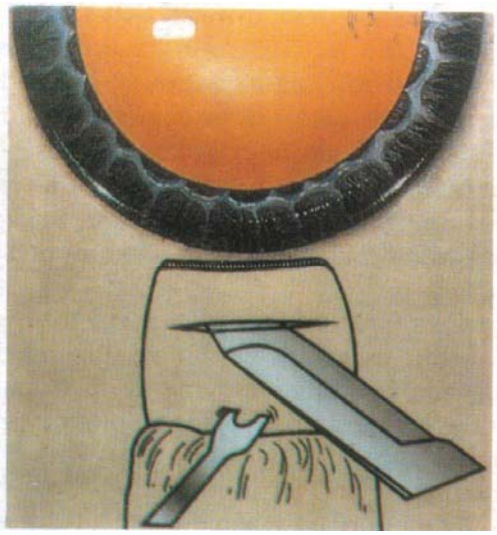
C. Which lies entirely within the funnel.

D. Moving the linear incision further away from the limbus will make it more stable but also hampers surgery by increasing the length of the tunnel and restricting the movement of instruments. It is more stable than curvilinear incision but not as stable as the frown incision.



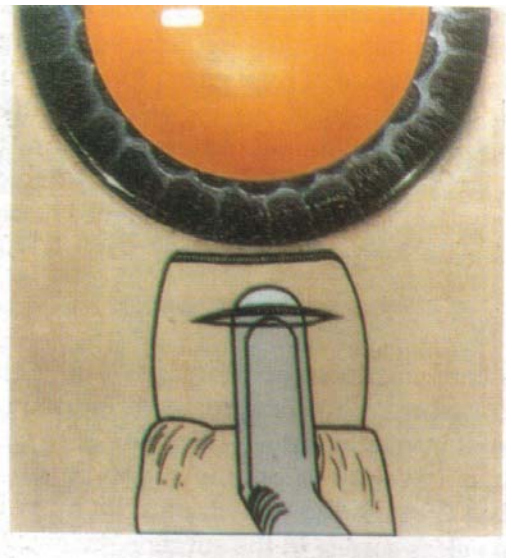
CONSTRUCTION OF SELF SEALING CORNEAL VALVE INCISION

INITIATION OF SCLERAL GROOVE

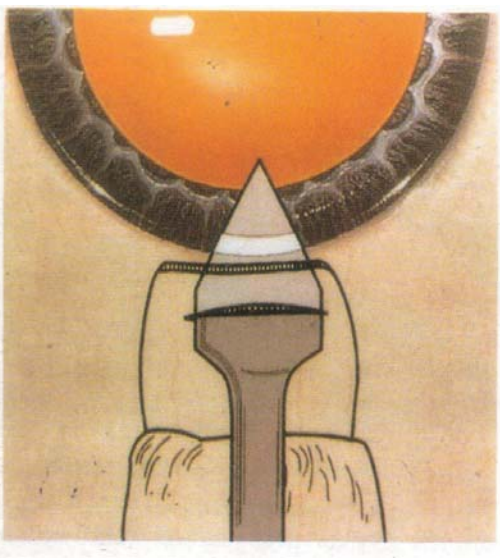


DIMPLING OF CORNEA BY DEPRESSING POINT OF KERATOME

TUNNELLING WITH A CRESCENT KNIFE



STRAIGHT LINE INCISION IN THE DECEMETS MEMBRANE 0.5 MM ANTERIOR TO VASCULAR ARCADE



The incisional funnel:

The concept of incisional funnel was introduced by **Paul Koch.**

It is an imaginary pair of curved lines diverging outwards from the limbus.

Incisions made within this funnel will be for all practical purpose Astigmatism – Neutral.

The internal incision:

This is the actual entry site into anterior chamber and has greater influence on astigmatism and wound stability.

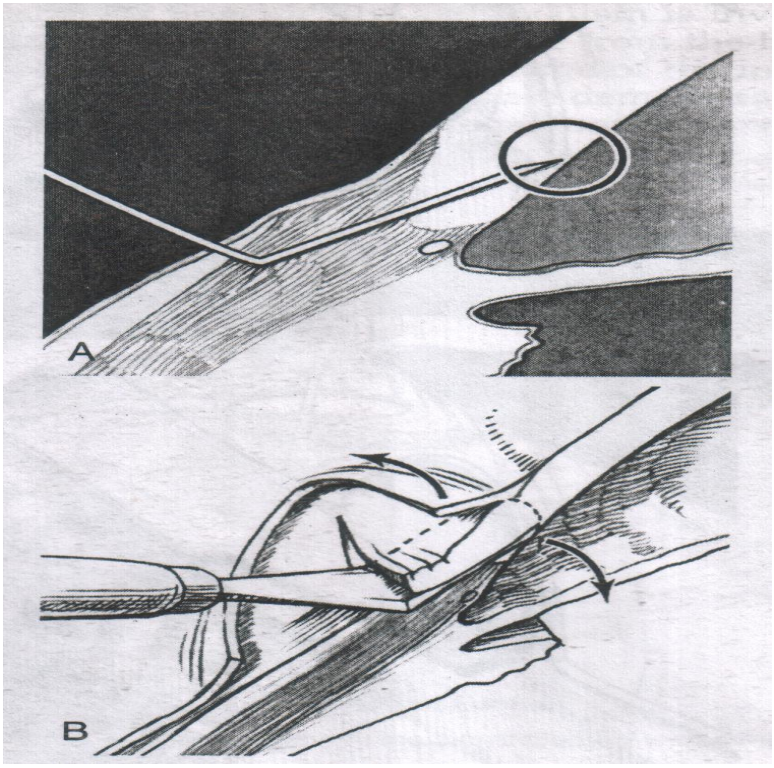
Construction of self sealing corneal valve incision:

This can be considered in 3 steps.

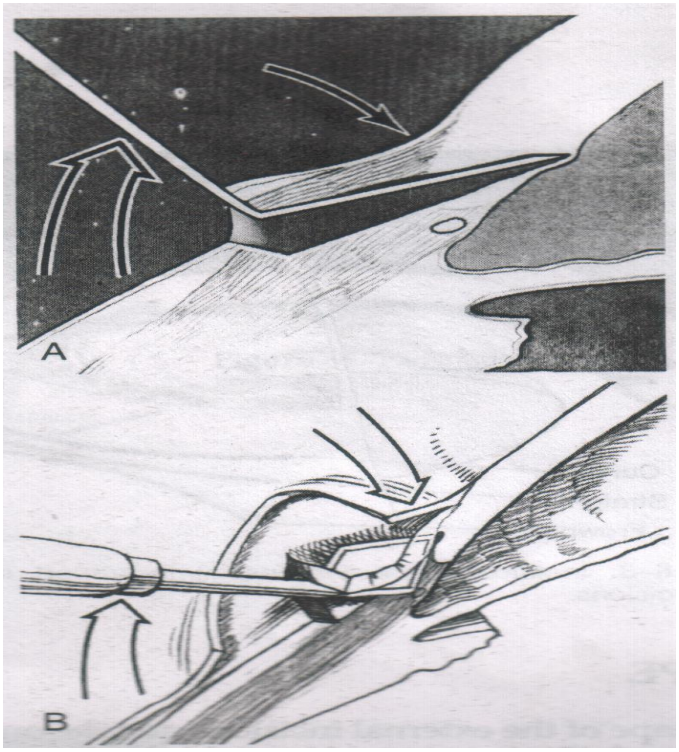
STEP-1: The **External or Scleral Incision** is placed within the incisional funnel and is ideally frown shaped to reduce post operative astigmatism. This provides maximum stability and less induced astigmatism. Also the middle of the incision is closer to the limbus, thereby shortening the tunnel distance and freeing instrument movement.

STEP-2: is the creation of **Scleral Tunnel** up to **1/3 to** ½ of **Scleral Thickness** and is carried forwards into the clear cornea till the anterior edge of the vascular arcade.

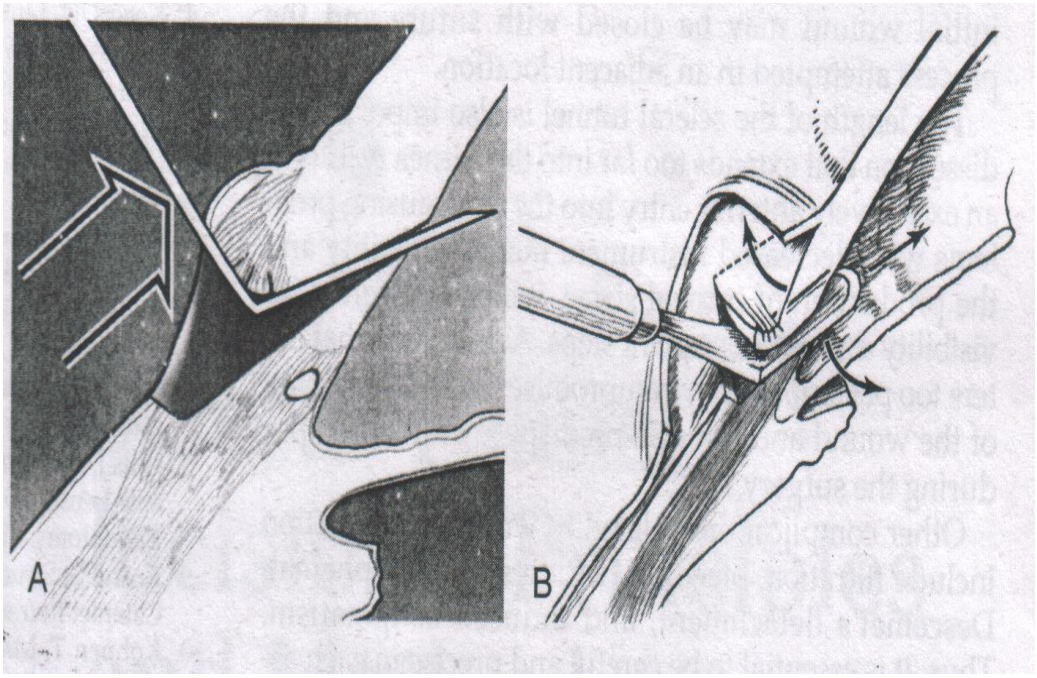
THE SCLERAL POCKET DISSECTION WITH A CRESCENT KNIFE.



THE DIMPLE DOWN MANEUVER CREATED WITH THE KERATOME PRIOR TO ENTRY INTO THE ANTERIOR CHAMBER.



ENLARGING THE INTERNAL INCISION WITH A CRESCENT KNIFE



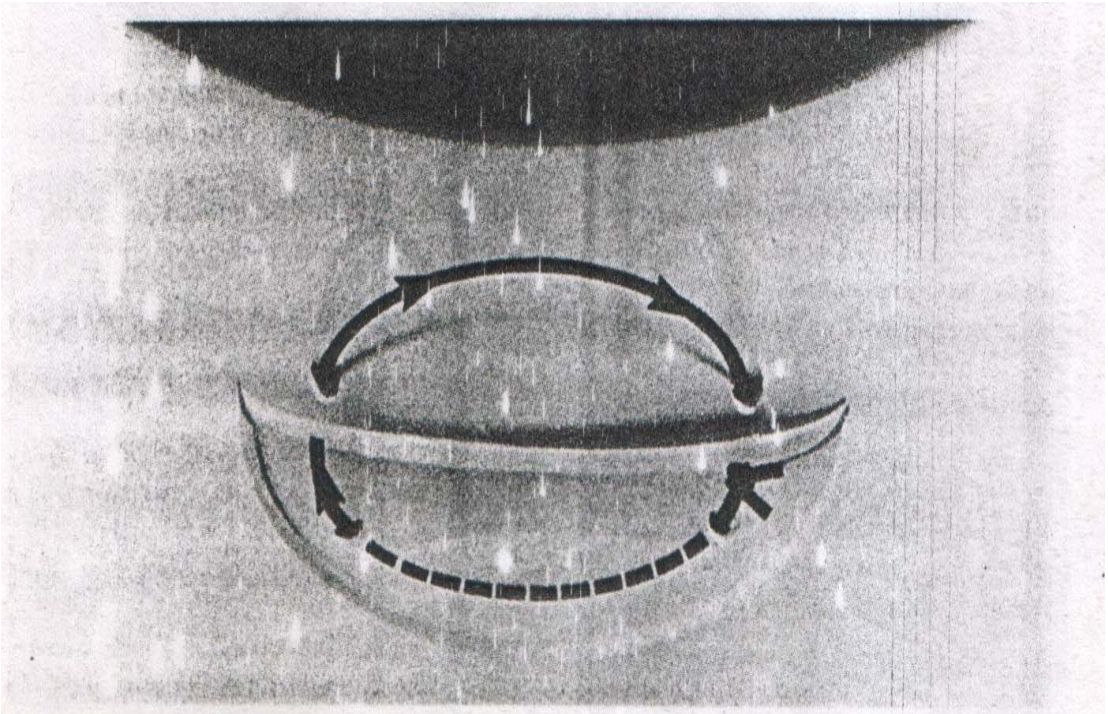


Fig. 2-35. Shephard technique of wound closure.

The first two steps are astigmatism neutral in that if the surgery is stopped at this stage, the corneal curvature is not altered.

It is the third step on the **internal entry into the cornea that** seems to alter the corneal curvature and hence is the **most important cause of corneal instability and astigmatism.**

To create the internal incision, a keratome is advanced into the dissected intracorneal tunnel, so that its point is just at the anterior edge of the vascular arcade. It is then advanced horizontally, parallel to the iris, resulting in a linear horizontal cut through descemet's membrane into the anterior chamber about 0.5mm anterior to the anterior edge of the vascular arcade. Thus a short posterior lip of clear cornea is created.

HOW DOES IT WORK?

As the intraocular pressure increases, pressure against the cornea squeezes against the intracorneal portion of the incision, sealing the corneal valve and making the incision water tight without sutures. Such a closure is the natural conclusion of the corneal valve incision, also known as the self sealing or sutureless incision.

Suturing:

The corneal valve is held closed by intraocular pressure which also acts to collapse the scleral tunnel. Thus no suture is required even if the scleral part of the incision is 6mm wide.

The wound can be tested for tightness by balanced salt solution (BSS) through the side port incision. Corneal tunnel incisions are self sealing and do not leak when the pressure is applied to the dome of the cornea. A suture may be added if the surgeon prefers more secure wound.

Sutures Commonly Used:

Healing will be more effective and rapid, if the edges of the wound are held in apportion during the first 4 to 5 days. This is the primary function of sutures.

Control of induced astigmatism has now become a major concern and sutures and needles are developed to serve this end.

Sutures:

The suture materials used in closing the cataract incisions are either of absorbable or of nonabsorbable type. Absorbable suture materials are catgut (plain or chromic), tendons of rat-tails, synthetic materials like polyglycolic acid (Dexon) and polyglactin (Vicryl) etc.

Non absorbable suture materials are human hair, silk (virgin or non virgin, braided or monofilament), newer synthetic material fibers (nylon, polypropylene, etc.

The currently used ones are silk, nylon, polypropelene, polyglactin etc. Other suture materials have been thought to be unfit for the delicacy needed in the cataract surgery.

Nonabsorbable sutures:

Silk: Silk is the oldest non absorbable suture material. Since silk is not inert, it may induce corneal vascularisation after months requiring suture removal. It is biodegradable.

Available in
- Virgin (with its natural sericin coating)
- Non virgin forms

Nylon: Nylon has become the **suture of choice** for **anterior segment surgery.** Monofilament nylon is **uniformly strong,** has no tissue drag, and has an average of **20% elasticity.** Elasticity provides **good wound apposition.**

It is **inert** resulting in a less inflamed eye which encourages a shorter convalescent period.

The knot of 10-0 nylon is sufficiently small so that it may be rotated into the suture track on the corneal side of the incision to prevent irritation.

Polypropylene:

It is synthetic. It has significant stretch characteristics not always returning to its original shape. It can cause significant induced astigmatism.

Polyester:

It is another synthetic material. It does not stretch.

It is totally unforgiving at the wound site and any induced astigmatism stays with the patient.

Needles:

Fine point spatula needles that cut with the tip and edges have been developed for cataract surgery. They have been developed to minimize tissue trauma as they pass through the cornea and to facilitate accurate placement.

Arc of needle in conjunction with the radius will determine the depth of the bite. A more curved needle with a short radius will take a deeper bite.

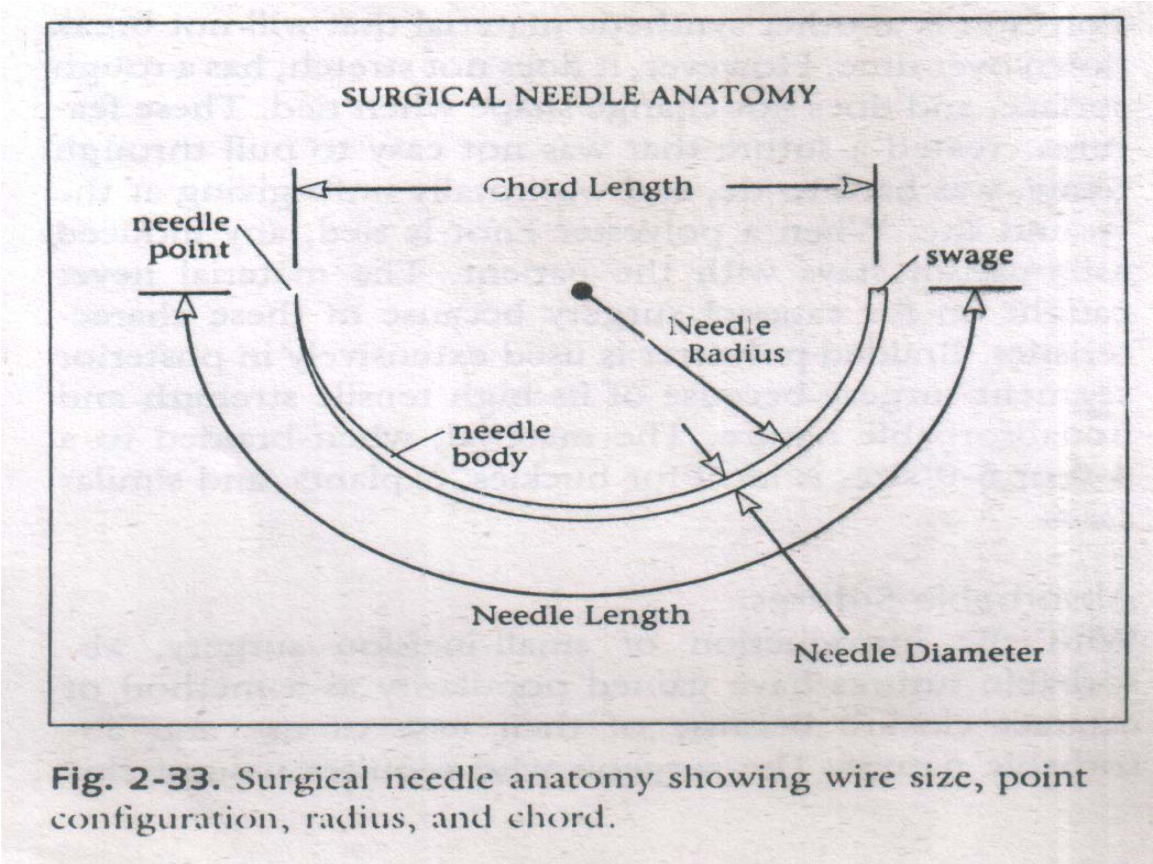
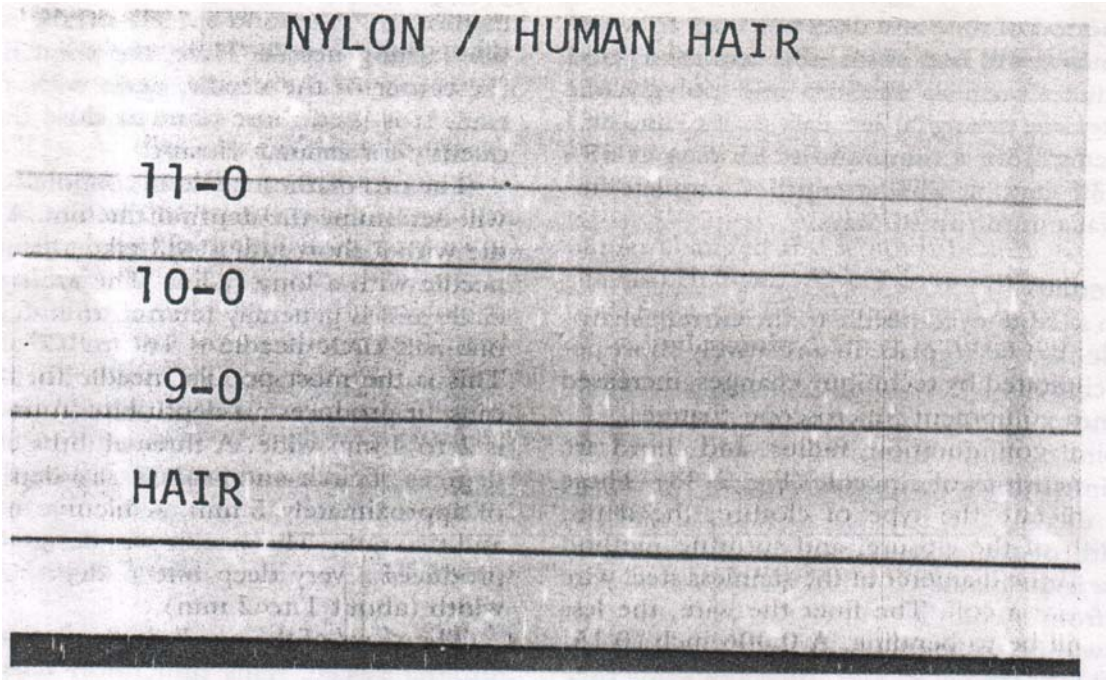


Fig. 2-33. Surgical needle anatomy showing wire size, point configuration, radius, and chord.

NYLON SUTURE STRAND SIZES, 9-0 TO 11-0, COMPARED WITH A HUMAN HAIR



The frequently used needle

- has 0.006 inch wire size diameter, one half circle with an arc of 160-175 degree body curvature,
- spatulated and side cutting .

  This produces a ¾ depth bite in tissue with a bite that is 2-4 mm wide which seems to be ideal for cataract surgery.

Types of incision closure:

A very common incision made 1.5mm back from the limbus consists of two planes. This type of wound requires less sutures and gives nearly perfect apposition to prevent postoperative astigmatism.

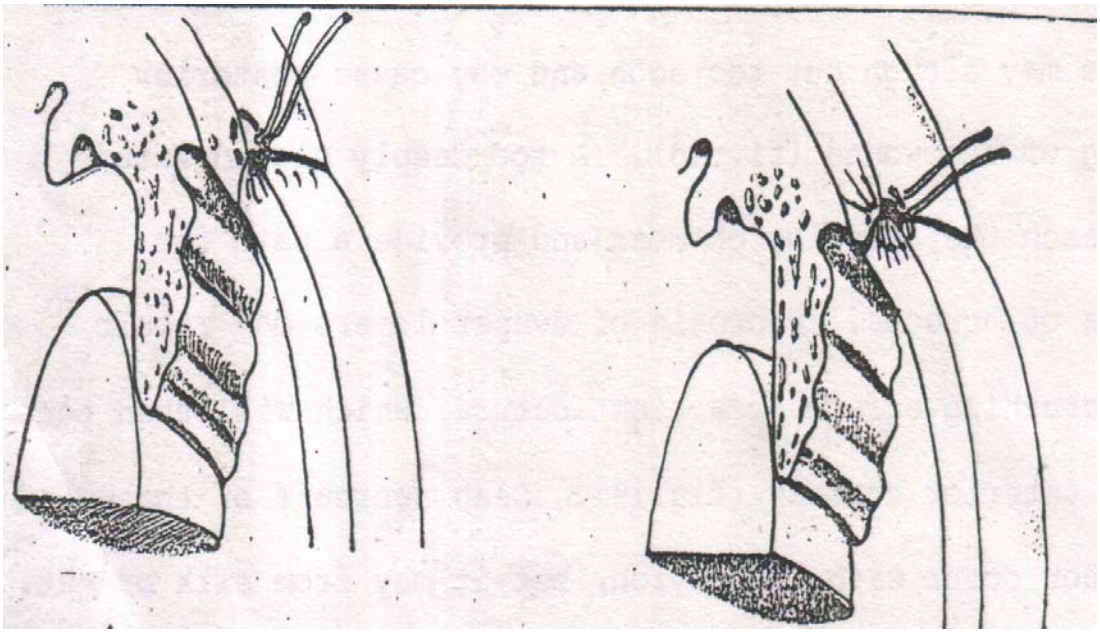
Original and still most popular type is a radial bite taken across the lips of the wound. This radial bite is ideal when made at ¾ to 7/8 depth thickness with a chord of about 2mm. The most popular needle for radial closure is a one half circle needle, with an arc of 160° and produces a chord of 4mm with 10-0 nylon suture.

The surgeon should strive to place the sutures equidistantly apart, to the same depth, as radial as possible and tie them with the same degree of tension. If the suture is placed at different depths on the two sides of the wound, wound

“DON’T’S” IN SUTURE TECHNIQUE

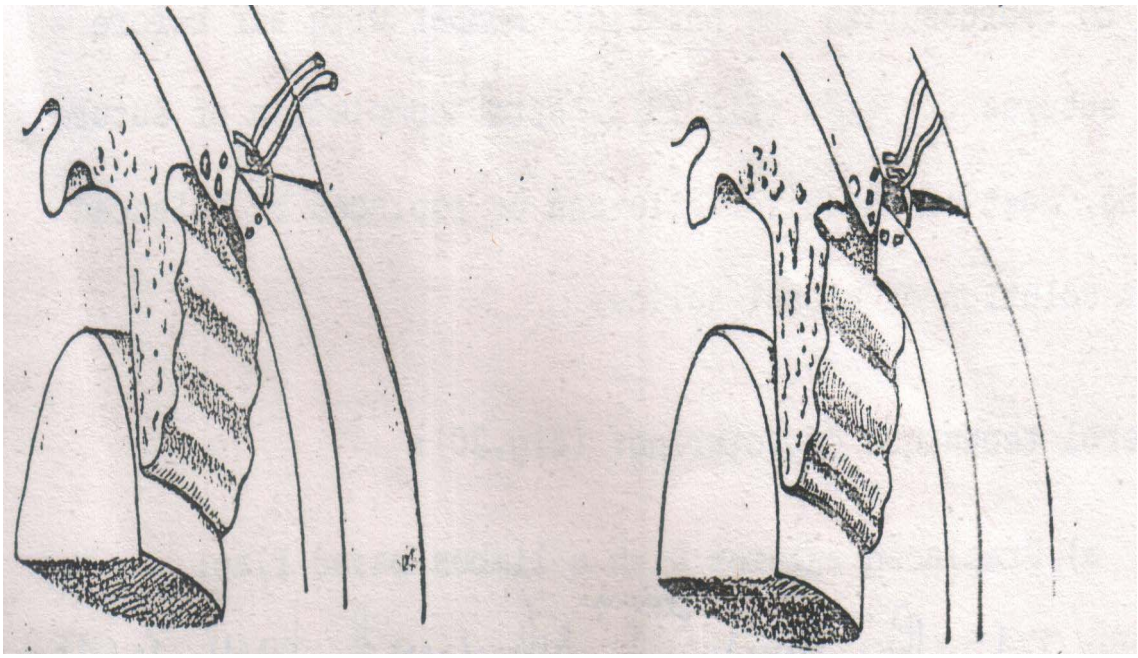
UNEQUAL BITE LENGTHS CAUSES WRINKLING

TOO TIGHT SUTURE CAUSES NECROSIS



THROUGH AND THROUGH SUTURE CAUSES POSTERIOR NECROSIS

UNEQUAL DEPTHS CAUSES GAPING, DELAYED HEALING DISTORTION



apposition suffers. If the length of the bite on both sides is unequal, wrinkling may occur when the suture is tied. The sutures must be tied sufficiently tight to unite the wound edges but not so tight to cause necrosis and posterior gaping. Excessive steepening and wrinkling of the cornea will appear if the suture is too tight.

. Shepherd first described the single horizontal suture for 4mm sclero corneal tunnel incision. This stitch merely apposes the scleral flap to the underlying bed & because it is oriented tangential to the cornea, it is said to be astigmatism neutral. Several methods of wound closure have been reported including the infinity closure, horizontal anchor suture etc. Some of the methods of sclero-corneal tunnel incision closure are shown in the next page.

Control of Postoperative Astigmatism

Effect of Cutting Sutures:

An effective method of reducing or eliminating the wound compression caused by sutures is the removal of one or more interrupted sutures in the meridian of greatest corneal curvature or in the severing of a continuous suture in the area of the steepest corneal meridian.

VARIOUS METHODS OF SCLERAL POCKET INCISION CLOSURE

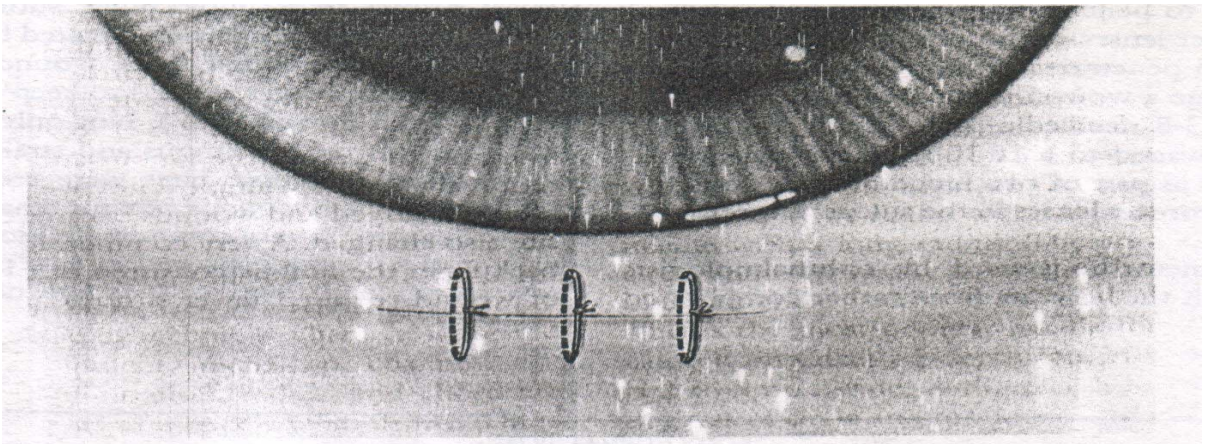


Fig. 2-36. Interrupted suture wound closure.

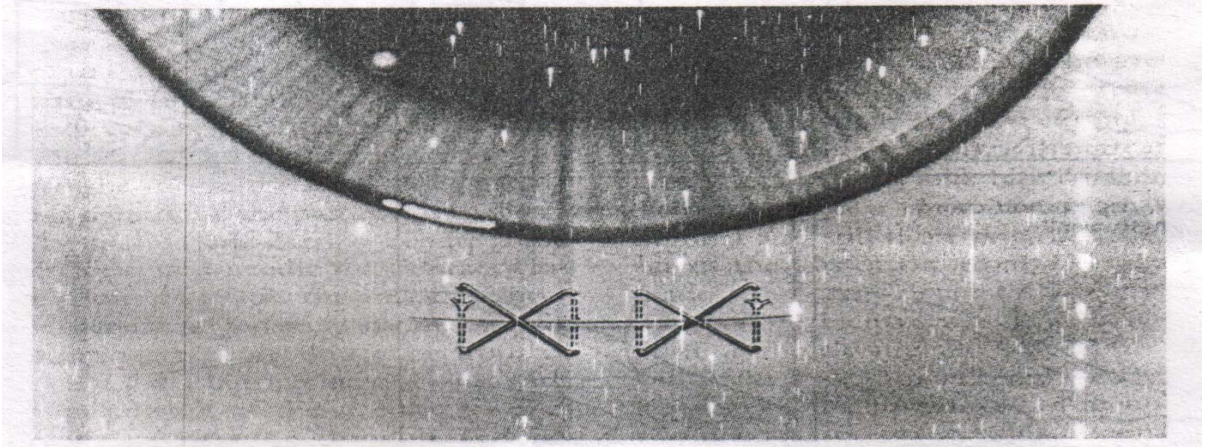


Fig. 2-37. Double-X wound closure.

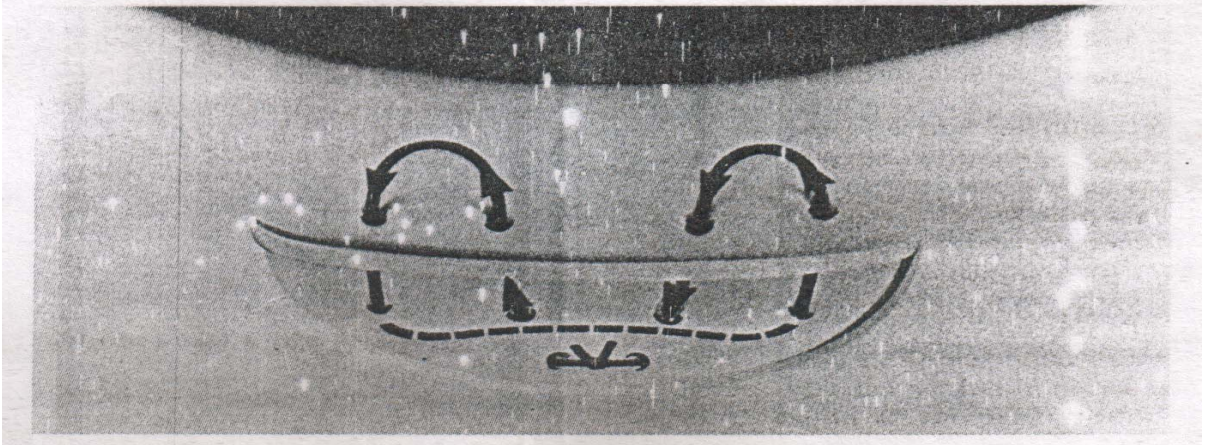


Fig. 2-38. Masket technique of wound closure.

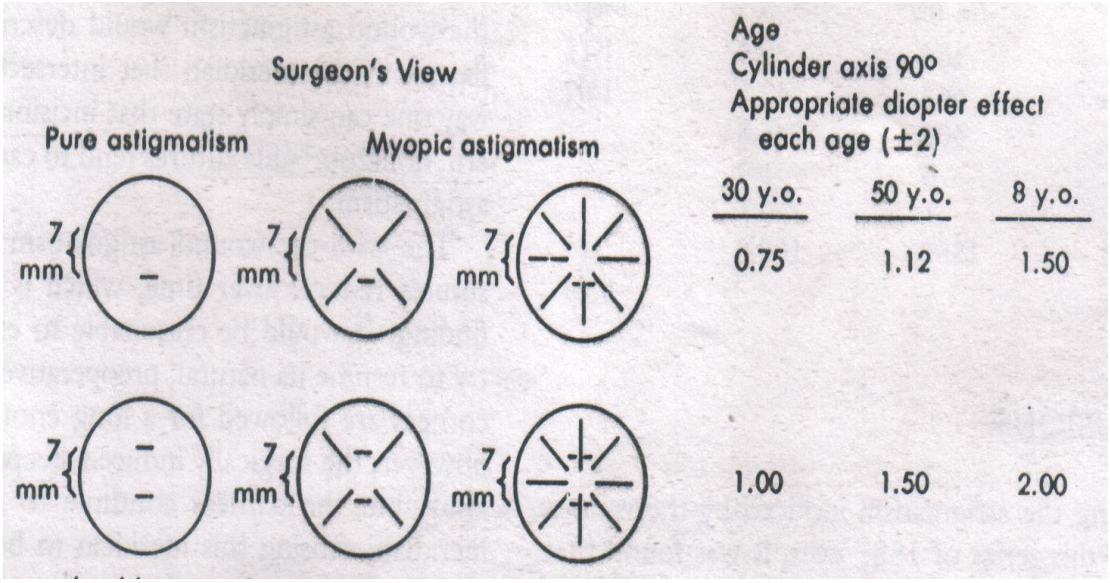
The rule to be remembered is to cut the suture in the axis of the correcting plus cylinder. This technique cannot be used in instances of astigmatism caused by wound gape.

Astigmatic Keratotomy:

Another method for the correction of postoperative corneal astigmatism has become available with the use of corneal astigmatic keratotomy techniques. These techniques have the advantage of being able to correct astigmatism caused by either wound compression or wound gape.

Lindstorm and Lavery have adapted this technique to aphakic and pseudophakic individuals. The radial incisions correct pure myopia and the non radial incisions (T-cuts) correct pure astigmatism. The greater the number of incisions and the closer these incisions are made to center of the cornea, the greater their effect will be. This evolving technique has the advantage of being able to correct against the wound astigmatism.

Lindstrom guide for correction of small amounts of postoperative astigmatism.

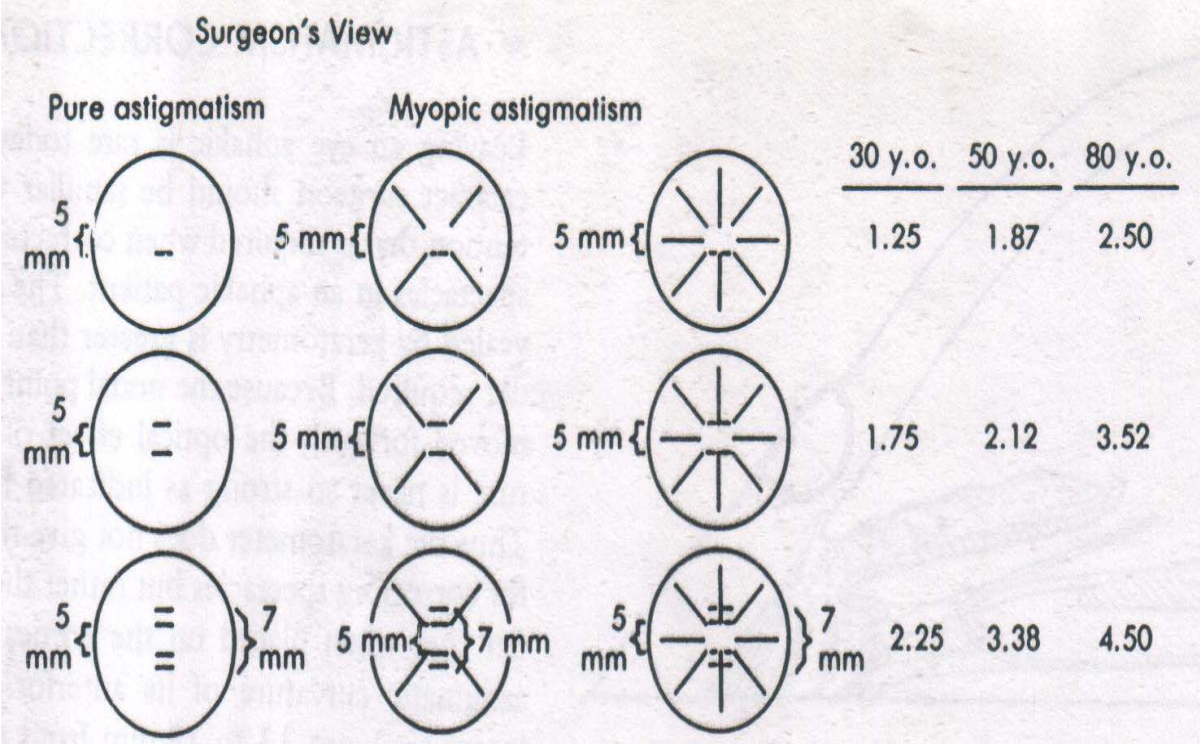


Age Cylinder axis 90° Appropriate diopter effect each age (±2)		
30 y.o.	50 y.o.	8 y.o.
0.75	1.12	1.50
1.00	1.50	2.00

T-cuts should not touch radials.

In T-cut cases, calculate myopic correction based on spherical equivalent.

Lindstrom Guide for correction of moderate amounts of postoperative astigmatism.



T-cuts should not touch radials.

In T-cut cases, calculate myopic correction based on spherical equivalent.

Lindstrom guide for correction of large amounts of postoperative astigmatism.

Radial incision optical zone	Approximate diopters effect at (y.o.) age (±3)		
	30 y.o.	55 y.o.	80 y.o.
3.0	5.5	8.25	11.0
3.5	4.5	6.75	9.0
4.0	3.75	5.62	7.5
4.5	3.0	4.50	6.0
5.0	2.5	3.75	5.0

PART - II

AIM OF THE STUDY

This present study

Compares and analyzes the magnitude and direction of early postoperative corneal astigmatism changes in a series of patients after manual small incision cataract surgery with preplanned 6mm long frown shaped sclerocorneal tunnel incision, without suture and with one radial anchoring suture using nonabsorbable 10’0 monofilament nylon, using Topographic Modeling System (TMS).

MATERIALS & METHODS

This documentation has been arrived at the end of the study of 50 Manual Small Incision Cataract Extractions, divided prospectively into two groups, Group A(No stitch group) and Group B(with single anchoring radial suture).

The entire preoperative evaluations, operative procedures and the postoperative follow ups were carried out at Regional Institute of Ophthalmology – Government Ophthalmic Hospital, Egmore, Chennai.

The study began in June 2005 and concluded in December 2005, covering a span of 7 months.

Similarity in the case studied was maintained as far as possible. This strategy included selection of age factor & uncomplicated cases. Risky cases like those associated with uncontrolled glaucoma, generalized debility, blood dyscrasias were excluded.

Also a special attention was paid not to give scope for the factor of variation in efficiency and skill of the operating hands. Hence the surgery was entirely performed in all the cases by **Prof.K.Vasantha, Chief, Cornea Services, RIO – GOH.**

Corneal topography pictures were taken using Corneal Topographic Modeling System(TMS) one day preoperatively.

Post operatively, corneal topography pictures were again taken at 2 days after surgery. Corneal curvature changes induced by surgical procedure and suturing method were assessed. Surgically induced astigmatic change was calculated using vector method of Jaffe and Clayman. (Ref. Cataract surgery and its complications by Norman. S. Jaffe).

All cases were admitted two days prior to surgery.

Preoperative evaluation includes:

1. Visual acuity with pin hole
2. Intraocular pressure in both eyes
3. Patency of lacrimal system
4. Active or indolent foci of sepsis in ear, nose, throat and lacrimal region were ruled out.
5. Thorough fundus examination of both eyes under full pupillary dilatation.
6. Examination of urine sample – for albumin and sugar, fasting blood sugar.
7. Blood pressure
8. Keratometry readings were noted with Bausch & Lomb keratometer in the greatest & least curved meridian of the cornea.

TOPOGRAPHIC MODELING SYSTEM, TMS, TOMEY.

9. **Corneal topography pictures were taken using TMS (Topographic modeling systems) Tomey one day prior to surgery**. Keratometry readings obtained were compared with corneal topography values preoperatively.

Patients were randomly allotted to one of the two series, Group A (without suture) or Group B (with single radial anchoring suture).

SURGICAL PROCEDURE UNDERTAKEN:

All the patients were operated under local anesthesia. 5ml of anesthetic solution, that is, mixture of 2% lignocaine with 1:1000 adrenaline with 50 units of Hyalase was given as peribulbar injection.

Eyelids and surrounding area were thoroughly cleaned with diluted betadine.

Exposure of the operative field was achieved by one upper eye lid and one lower eyelid traction sutures.

The conjunctival sac was washed with diluted betadine and balanced salt solution. A superior rectus bridle suture was put for fixation & eyeball was rotated downwards.

A fornix based conjunctival flap was made just sufficient to accommodate the incision. Hemostasis was then achieved with bipolar wetfield cautery to blanch the exposed episcleral & scleral vessels.

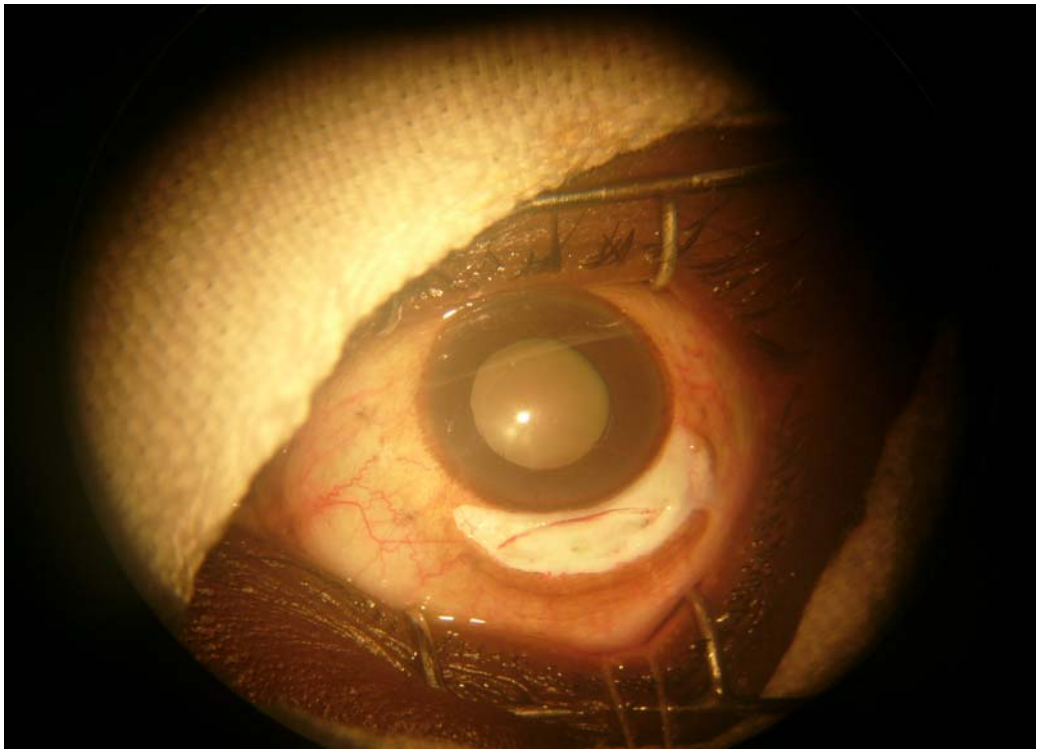
Subsequently the external scleral incision was made.

Configuration of scleral incision used:

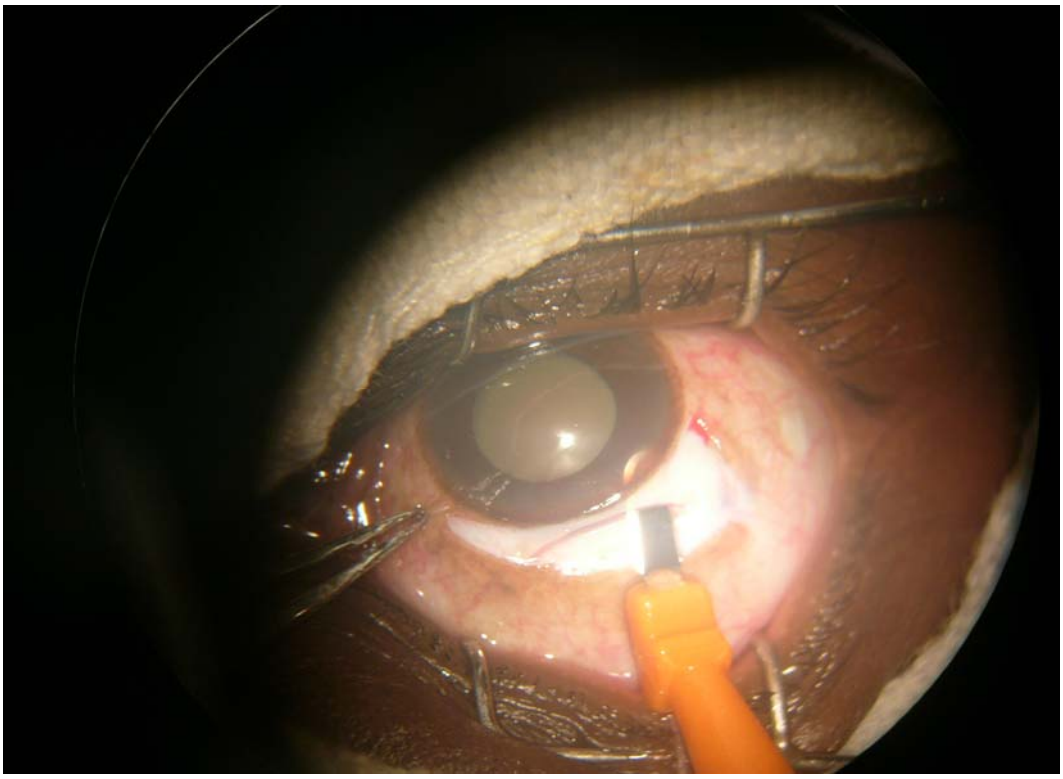
Frown shaped 6mm long external scleral incision was made 2 mm posterior to the anterior limbal border (measurements confirmed with Castroviejo caliper in every case) with a sharp guarded diamond knife to create ½ depth scleral groove.

Then the bevel up rounded crescent blade engaged into the scleral groove and its lamellae split along the entire length by gentle wiggled side to side movement with forward pressure. The tunnel was extended up to 1mm into the clear cornea, just anterior to the vascular arcade. Careful attention was paid to assure that dissection remains at desired depth along its entire length. While entering into cornea tip of blade was kept up to follow its curvature.

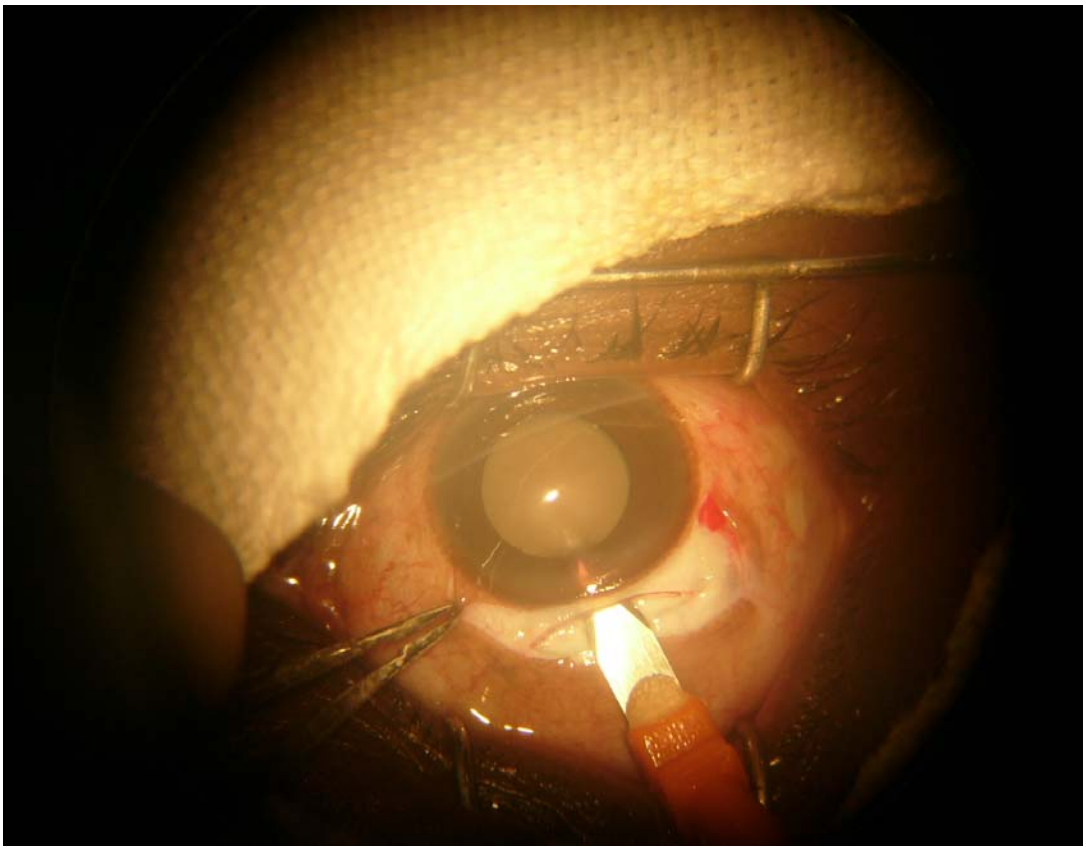
EXTERNAL FROWN SHAPED SCLERAL GROOVE



THE SCLERO CORNEAL POCKET DISSECTION WITH A CRESCENT KNIFE



THE DIMPLE DOWN MANEUVER CREATED WITH THE KERATOME PRIOR TO ENTRY INTO THE ANTERIOR CHAMBER



Then 2.8 mm diamond keratome was passed through the tunnel and at the anterior border of tunnel in the clear cornea, the tip was angled down to create a dimpling in the cornea. And anterior chamber was entered.

Thus the scleral tunnel incision had three components.

1. External Frown shaped scleral incision.
2. Sclerocorneal tunnel
3. Internal corneal incision in to Anterior Chamber.

Capsulotomy:

After entering the anterior chamber with keratome, viscoelastic (2% hydroxy propyl methyl cellulose) was injected and continuous curvilinear capsulorhexis was made in all cases. A side port incision was created using a side port knife about 120º away from the main incision. Tunnel incision was enlarged with the blunt tip extention knife cutting on the inward stroke, to the full extent of the external incision.

Hydrodissection was done. Nucleus was brought into the anterior chamber & viscoelastic was injected both above & below the nucleus.

Nucleus Delivery:

Irrigating vectis was passed under the nucleus & the nucleus was delivered out by hydroextraction**.**

Cortical Wash:

The residual cortical material was removed using two way simcoe cannula.

IOL Implantation:

Single piece PMMA Intra Ocular Lens of appropriate power, with optic diameter of 6mm,was then inserted into the capsular bag.

Closing the Scleral Tunnel:

The Anterior Chamber was inflated with fluid from side port. The inferior limbus and dome of cornea was pressed to check the integrity of the wound.

Then according to random allocation of series,in case of Group B patients– a single radial anchoring suture using nonabsorbable monofilament nylon suture, each bite 1mm from incision margin, at similar depth on either side of wound margin, tied with triple surgeon’s knots in the first tie, two knots in the second tie & final single knot in the third tie was applied. Sutures were cut flush with the knot. The knot was finally kept on the scleral side of the incision. Conjunctival flap repositioned.

In case Group A patients:

After checking the tunnel incision for leaking, by pressing the inferior limbus and dome of cornea and confirming the integrity of valve, cases were left without suture.

Subconjunctival injection of 0.5ml of gentamycin and 0.5ml dexamethasone was instilled in the subconjunctival sac. Pad & Bandage were applied. Post operatively, analgesics, sedatives & antibiotics were prescribed.

Dressing was changed and eye shade was given the next day. Topical antibiotic steroid combination drops and cyclopentolate eye drops were applied. Wound approximation, depth of anterior chamber, clarity of anterior chamber, status of fundus were examined. Any complications like striate keratitis were treated. Postoperative vision with pinhole was tested.

Corneal topography was repeated for all cases on 2nd postoperative day using Topographic Modeling System (TMS) and postoperative astigmatism assessed and compared with preoperative astigmatism.

The patients were instructed to continue topical antibiotic steroid eye drops 2hrly and advised to come for the first follow up after one week & and then every second week & then for Dilatation / RR/Fundus Examination after 6 weeks.

OBSERVATION AND DISCUSSION

Surgically induced astigmatism comparison of sutured and unsutured 6.0mm scleral pocket incisions.

Patient Demographics

	Group A (No stitch group)	**Group B (with single vertical anchoring stitch)**
Number of Patients	**25**	**25**
Mean Age	**57.72**	**58.24**

Topographic analysis was made preoperatively and postoperatively at day 2. Preoperative data base included age, sex, visual acuity and corneal topography values. Operative information included incision size, closure technique whether with or without suture and complications.

Analysis of astigmatic cylinder was restricted to corneal topographic system only because this is an objective measure of corneal contour, not influenced preoperatively by cataract which may affect the refraction or postoperatively by subjective patient's perception.

Change in keratometric cylinder was examined in two ways.

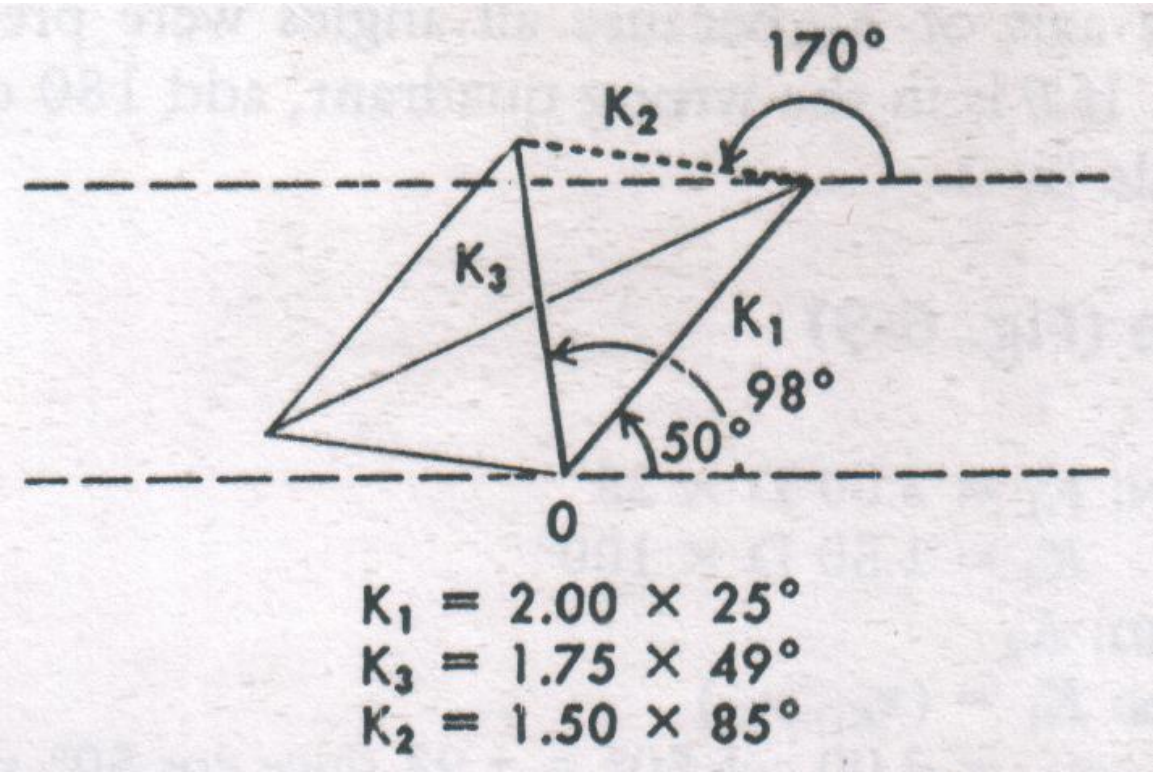
1. **The vector analysis method of determining the induced cylinder change described by Jaffe and Clayman** (Ref. The pathophysiology of corneal astigmatism after cataract surgery, Journal – Trans Am. Academy of ophthalmology otolaryngology and Textbook of Cataract Surgery and its Complications by Norman S. Jaffe). This method is explained in the next page. By this method, all induced cylinder has a positive value. Induced cylinder is not necessarily increased cylinder.
2. **The simple subtraction method of calculating cylinder change without regard to axis.**

   Differences between the induced cylindrical change were analyzed using **two tailed paired t tests.**

   In three cases in each group, where there is steepening of >1D, incision was placed superiorly or superotemporally in the steepest meridian according to the axis. Of these, two out of three cases in Group A (No stitch group) showed decrease in postoperative cylinder (> 0.5D) that is decrease in preexisting steepening in the meridian that intersects the incision. In case of Group B (With single radial suture) only one case out of three showed very small amount of decrease in preexisting cylinder (0.05 D) that is no significant flattening in the meridian that intersects the incision.

Vector Method of Jaffe to calculate surgically induced astigmatism

To calculate the surgically induced cylinder K2, a simple variation of the parallelogram is used by construction of a triangle using graph paper and protractor.



Because we already know preoperative corneal astigmatism (K1) and Postoperative corneal astigmatism (K3), we find the surgically induced change (K2) by drawing a line connecting the end of K1 to the end of K3. The axis of K2 is determined by placing the protractor at the end of K1 and dividing the angle by 2.

(From Jaffe NS, Clayman HM: Trans' Am Acad Ophthalmology Otolaryngology 79:OP615-630, 1975).

ASSESMENT OF AXIS CHANGE OF CYLINDER

GROUP A (No stitch Group) shows that,

(Cylinders between 70 and 110 degree was considered WTR, Cylinders between 160 and 20 degrees ATR, Axes in between considered Oblique).

WTR: with the rule, ATR: against the rule, Oblique: Oblique axis

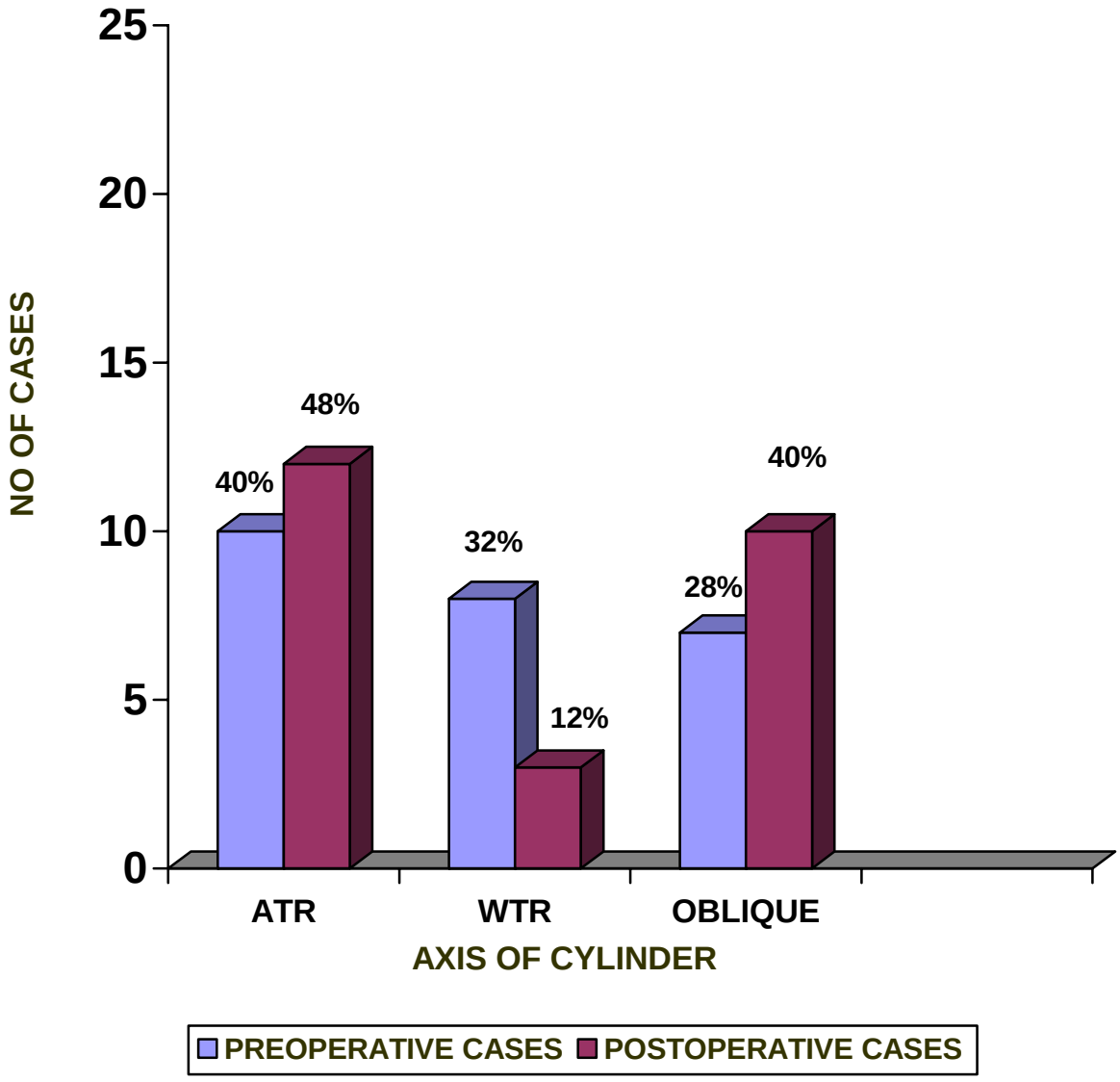
Preoperative Astigmatism

S.No	Type of Astigmatism	No of Cases	Percentage
1.	Against the rule	10	40%
2.	With the rule	8	32%
3.	Oblique	7	28%

Postoperative Astigmatism

S.No	Type of Astigmatism	No of Cases	Percentage
1.	Against the rule	12	48%
2.	With the rule	3	12%
3.	Oblique	10	40%

COMPARISON OF CYLINDER AXES BETWEEN PREOPERATIVE AND POSTOPERATIVE CASES OF GROUP A (NO SUTURE GROUP)



Net Induced Cylinder

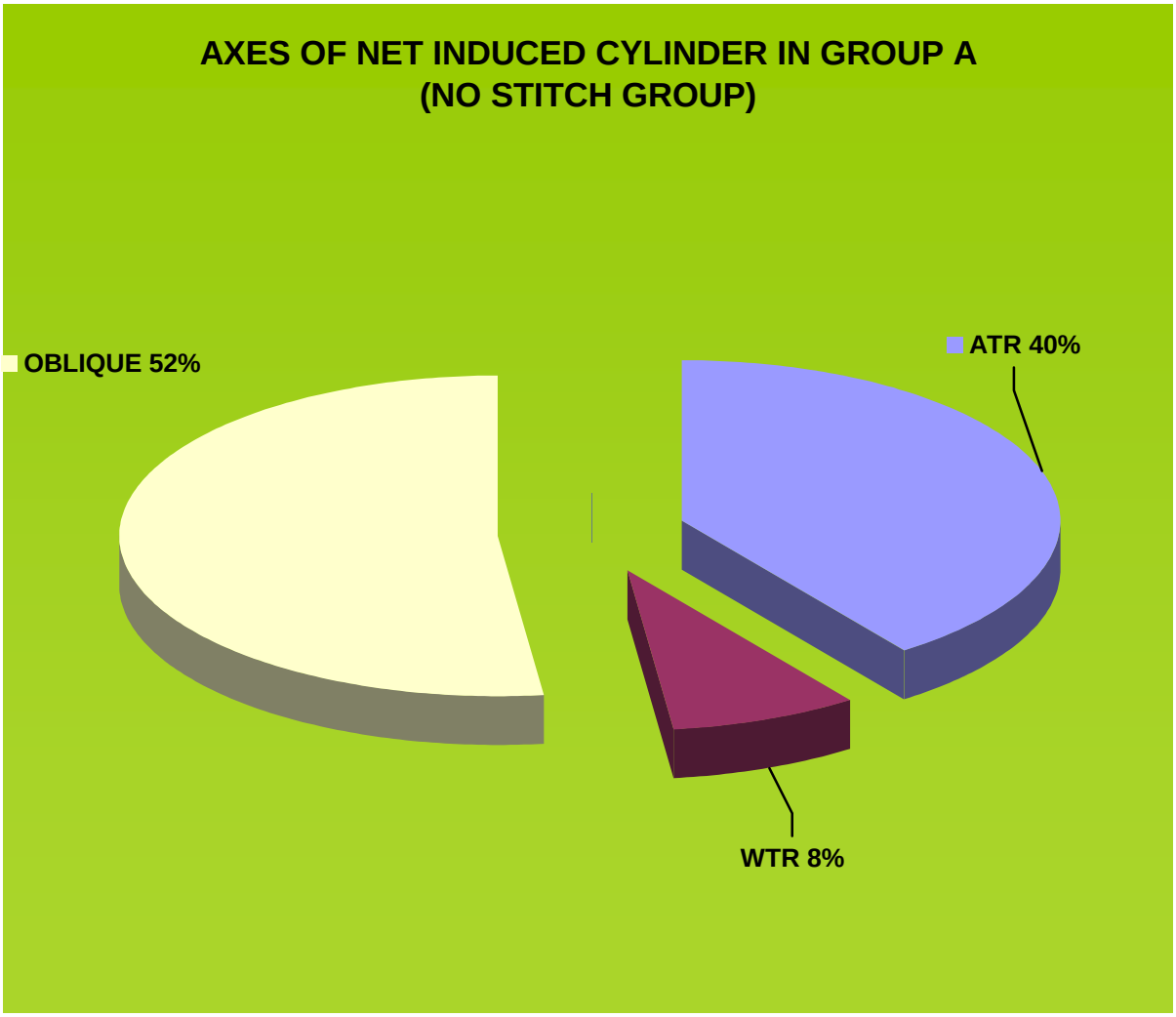
Type of Astigmatism	No of Cases	Percentage
ATR	10	40%
WTR	2	8%
OBLIQUE	13	52%
Total	**25**	

Hence there is net tendency towards oblique (which is more towards the against the rule type) and against the rule astigmatism.

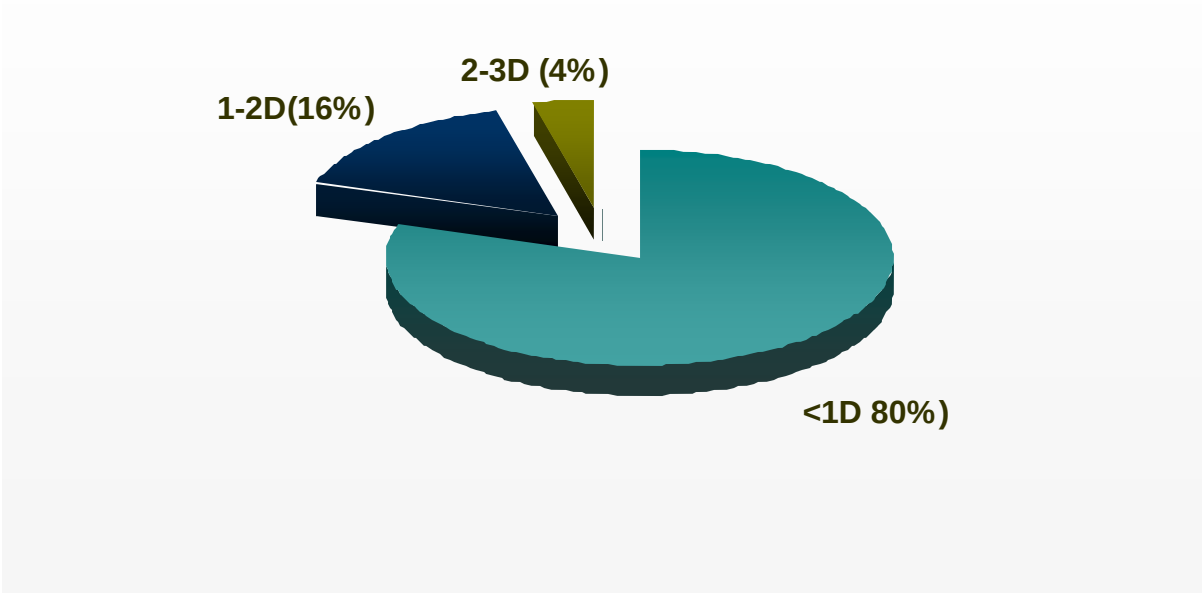
Only 8% cases showed induced cylinder of with the rule type

Severity of Induced Astigmatism.

Amplitude of Cylinder	<1 D	1-2 D	2-3 D	> 3D
No of Cases	20	4	1	Nil


AXES OF NET INDUCED CYLINDER IN GROUP A
(NO STITCH GROUP)
OBLIQUE 52%
ATR 40%
WTR 8%

SEVERITY OF INDUCED ASTIGMATISM IN GROUP A (NO STITCH GROUP)



Group B(with Single Stitch Group)

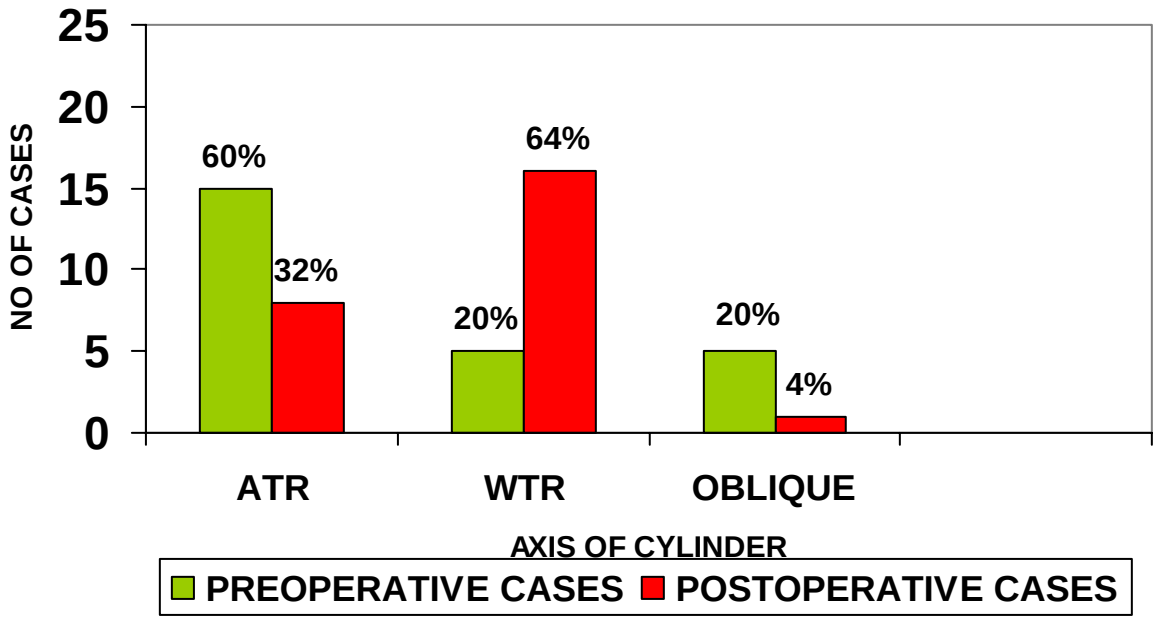
PREOPERATIVE ASTIGMATISM:

S.No	Type of Astigmatism	No of Cases	Percentage
1.	Against the rule	15	60%
2.	With the rule	5	20%
3.	Oblique	5	20%

Postoperative Astigmatism

S.No	Type of Astigmatism	No of Cases	Percentage
1.	Against the rule	8	32%
2.	With the rule	16	64%
3.	Oblique	1	4%

COMPARISON OF CYLINDER AXES BETWEEN PREOPERATIVE AND POSTOPERATIVE CASES OF GROUP B (WITH SINGLE RADIAL SUTURE)



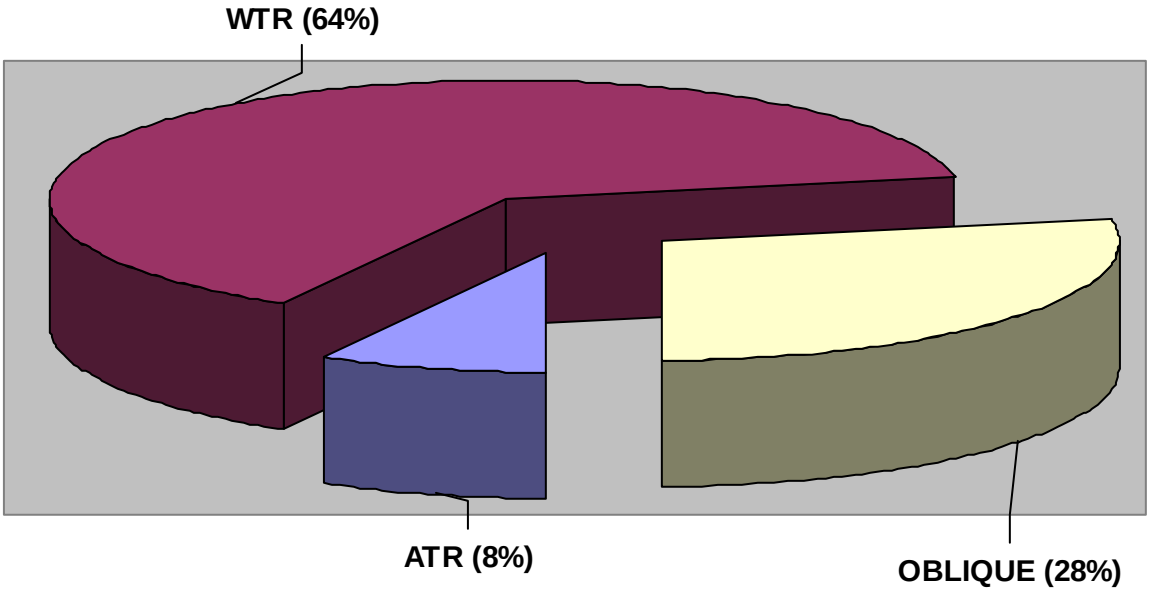
Net Induced Cylinder

Type of Astigmatism	No of Cases	Percentage
ATR	2	8%
WTR	16	64%
OBLIQUE	7	28%
Total	**25**	

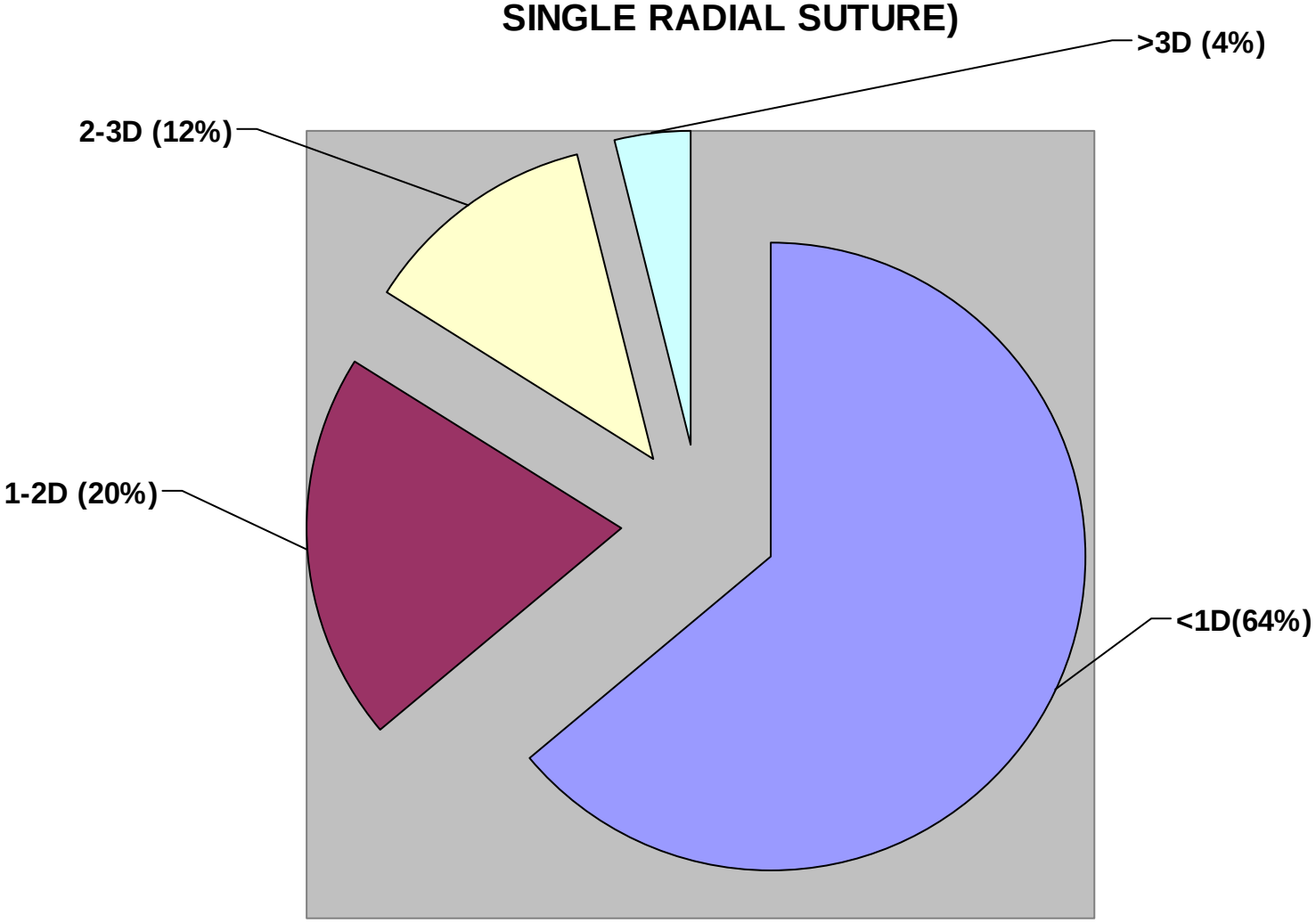
Hence there is a tendency of with the rule type of astigmatism postoperatively in cases where one radial anchoring suture was placed.

Amplitude of Cylinder	<1.0 D	1-2 D	2-3 D	> 3D
No of Cases	16	5	2	1

AXES OF NET INDUCED CYLINDER IN GROUP B
(WITH SINGLE RADIAL SUTURE)



SEVERITY OF NET INDUCED CYLINDER IN GROUP B (WITH SINGLE RADIAL SUTURE)



GROUP A – No stitch Group.

(Based on vector Method of Jaffe)

S.No	Induced Cylinder Dioptre X	Mean $\bar{X}$	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.6	0.71	+ 0.89	0.7921
2.	0.7	0.71	-0.01	0.0001
3.	0.3	0.71	- 0.41	0.1681
4.	1.6	0.71	+ 0.89	0.7921
5.	0.3	0.71	-0.41	0.1681
6.	0.5	0.71	-0.21	0.0441
7.	1.0	0.71	+0.29	0.0841
8.	0.4	0.71	- 0.31	0.0576
9.	2.8	0.71	+2.09	4.3681
10.	0.8	0.71	+0.09	0.0008
11.	0.4	0.71	-0.24	0.0961
12.	0.7	0.71	- 0.01	0.0001
13.	0.4	0.71	- 0.31	0.0961
14.	0.9	0.71	+1.19	0.0361
15.	0.6	0.71	- 0.11	0.0121
16.	0.2	0.71	-0.51	0.2601
17.	0.1	0.71	- 0.61	0.3721
18.	0.1	0.71	- 0.61	0.3721
19.	0.7	0.71	- 0.01	0.0001
20.	0.6	0.71	- 0.11	0.0121
21.	0.2	0.71	- 0.51	0.2601
22.	0.5	0.71	- 0.21	0.0441
23.	0.3	0.71	- 0.41	0.1681
24.	0.4	0.71	- 0.31	0.0961
25.	1.1	0.71	+ 0.39	0.1521

Standard Deviation $\sqrt{\frac{(X - \bar{X})^2}{n-1}}$ (Since Sample size is less than 30)

SD (A) = 0.5877

GROUP B (with single radial anchoring stitch)

S.NO	Induced Cylinder Dioptre X	Mean $\overline{X}$	$(X - \overline{X})$	$(X - \overline{X})^2$
1	3.2	0.97	2.23	4.9729
2.	1.4	0.97	0.43	0.1849
3.	0.4	0.97	-0.57	0.3249
4.	1.8	0.97	0.83	0.6883
5.	1.6	0.97	0.63	0.3969
6.	1.2	0.97	0.23	0.0529
7.	2.3	0.97	1.33	1.7689
8.	0.5	0.97	-0.47	0.2209
9.	2.3	0.97	1.33	1.7689
10.	0.3	0.97	-0.67	0.4489
11.	0.3	0.97	-0.67	0.4489
12.	0.05	0.97	-0.92	0.8464
13.	0.5	0.97	-0.47	0.2209
14.	0.7	0.97	-0.27	0.0729
15.	0.7	0.97	-0.27	0.0729
16.	2.3	0.97	1.33	1.7689
17.	0.5	0.97	- 0.47	0.2209
18.	0.5	0.97	- 0.47	0.2209
19.	0.9	0.97	- 0.07	0.0049
20.	1.2	0.97	- 0.23	0.0529
21.	0.5	0.97	- 0.47	0.2209
22.	0.5	0.97	- 0.47	0.2209
23.	0.2	0.97	- 0.72	0.5184
24.	0.8	0.97	- 0.17	0.0289
25.	0.1	0.97	-0.87	0.7569

Standard Deviation $\sqrt{\frac{(X - \overline{X})^2}{n-1}}$

SD (B) = 0.8293

ASSESMENT OF MAGNITUDE OF INDUCED CYLINDER

Comparison of two groups by two tailed paired "t" test

Mean induced cylinder between two groups

Based on vector analysis method of Jaffe at postoperative

interval of 2nd day.

Group A No stitch	No of Cases 25	Induced Cylinder Mean in Dioptres 0.706 (0.5877)
Group B Anchor Stitch	No of Cases 25	0.992 (0.8293)

Number in parenthesis represent standard deviation.

TO CALCULATE THE STANDARD ERROR OF DIFFERENCE BETWEEN THE MEAN

$$\text{Standard Error} = \sqrt{\frac{[\text{SD (A)}]^2}{\text{n (A)}} + \frac{[\text{SD (B)}]^2}{\text{n (B)}}}$$

$$= \sqrt{\frac{[0.5877]^2}{25} + \frac{[0.8293]^2}{25}}$$

$$= \sqrt{\frac{0.3455}{25} + \frac{0.6877}{25}}$$

$$= \sqrt{0.0138 + 0.0275}$$

$$= \sqrt{0.0413}$$

$$\text{SE} = 0.2032$$

Applying to ‘t’ Statistic

$$t = \frac{\text{Actual Difference Between Mean}}{\text{SE of Difference Between Mean}}$$

$$= \frac{0.99 - 0.71}{0.2032}$$

$$t = 1.377$$

To test the Null Hypothesis

Null Hypothesis is set as : Mean Induced cylinder in Group A = Mean Induced cylinder in Group B

Alternate Hypothesis is set as : Mean Induced cylinder in Group A < Mean Induced cylinder in Group B

At a significance level of 0.05 that is 95% Confidence Limits

From Table

Critical Value of t = 1.708

Observed Value of 't' obtained = 1.377

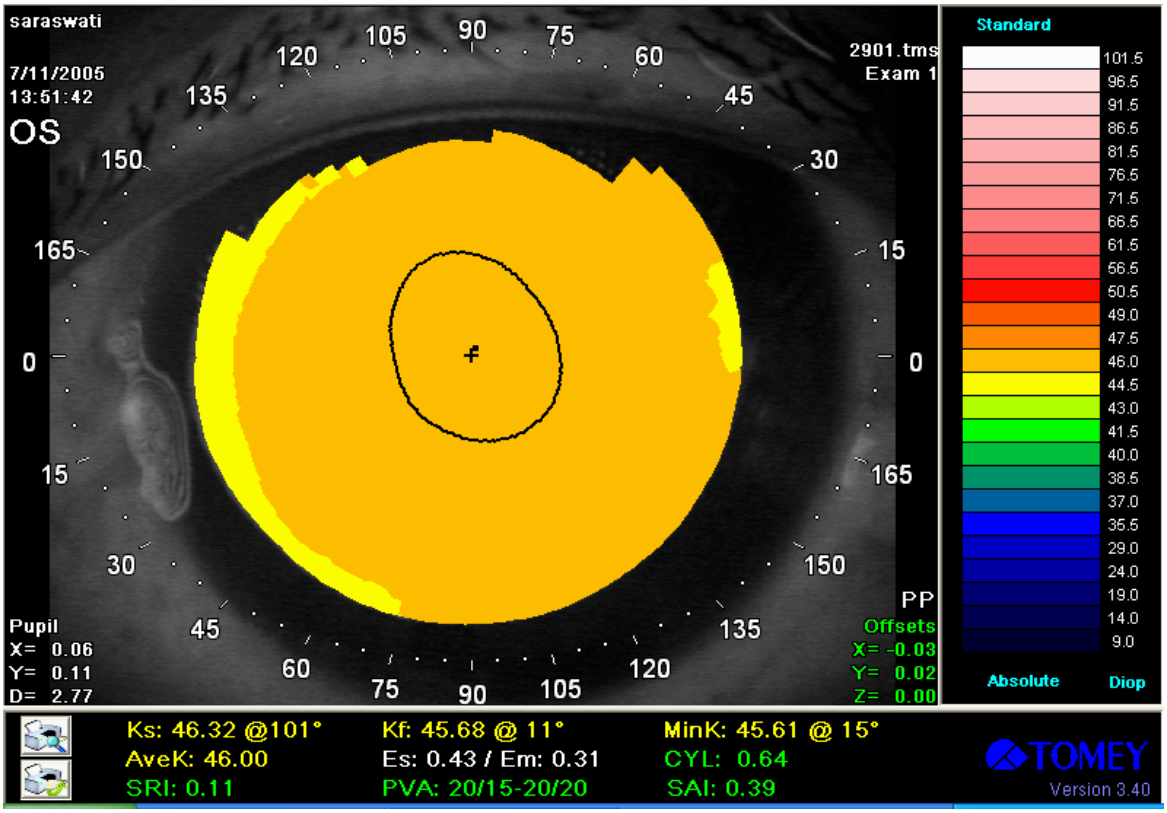
which is less than the critical 't' value. So we conclude.

Null hypothesis is true, that is there is no statistically significant difference between the amplitude of induced cylinder between Group A and Group B.

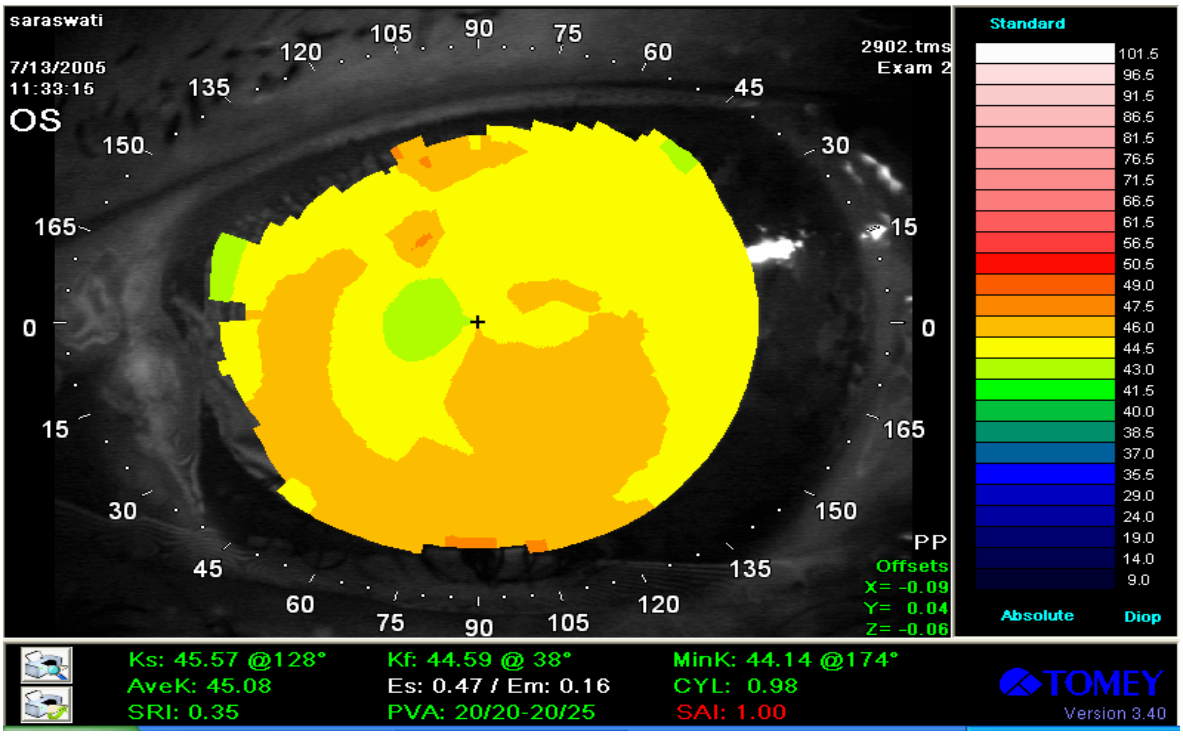
The Group A (No stitch Group) showed tendency towards Against The Rule type of Astigmatism Group B (Single Stitch Group) showed tendency towards With The Rule type of astigmatism.

Group – A (No Stitch Group) Eye showing flattening towards the scleral tunnel incision wound postoperatively.

PREOPERATIVE TOPOGRAPHY

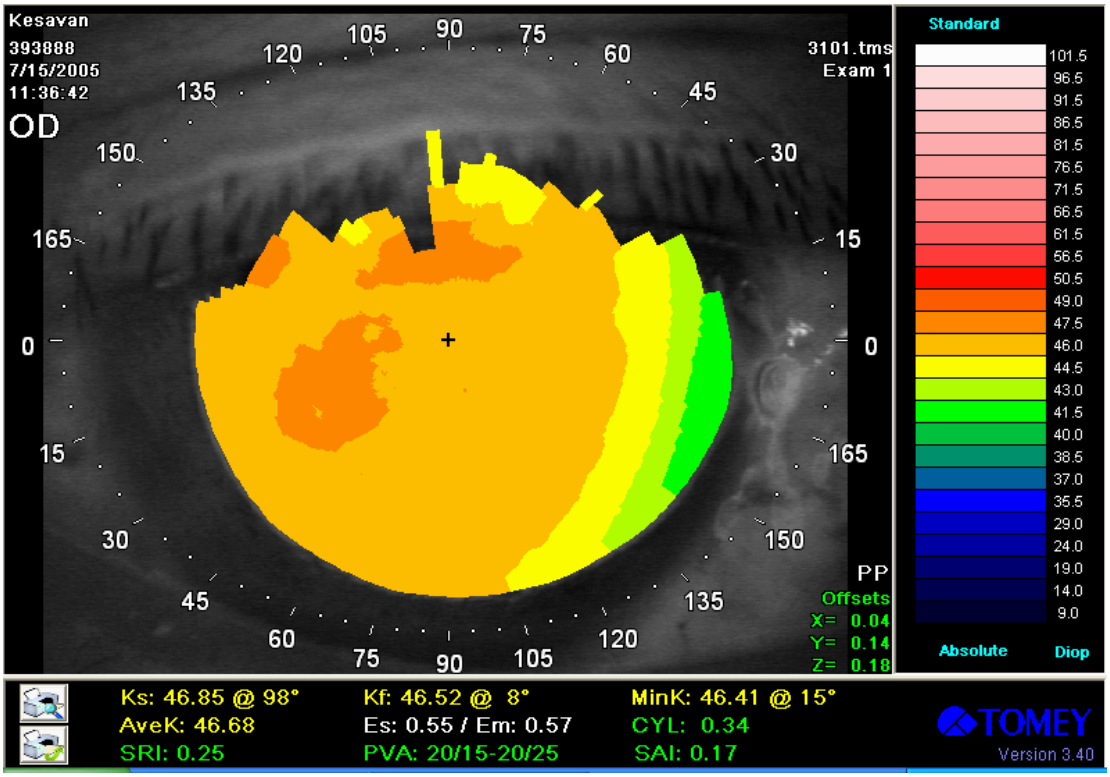


POSTOPERATIVE TOPOGRAPHY

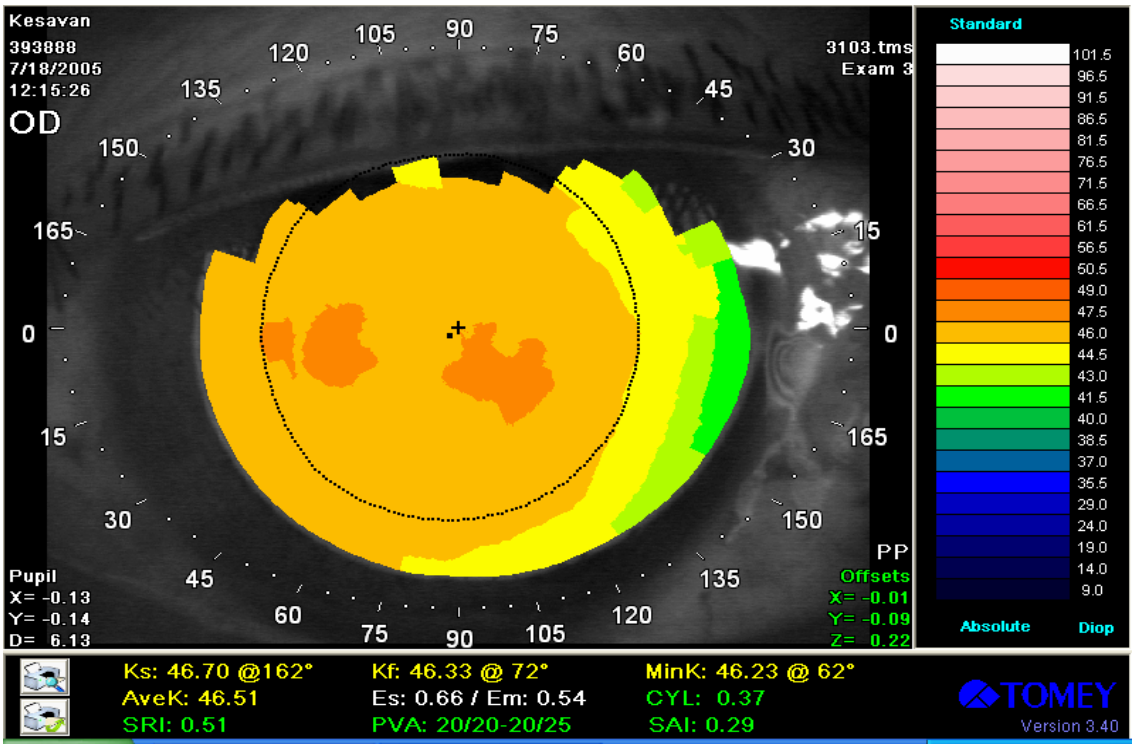


Group A (No stitch Group) Eye showing minimal induced astigmatism of against the rule type postoperatively.

PREOPERATIVE TOPOGRAPHY

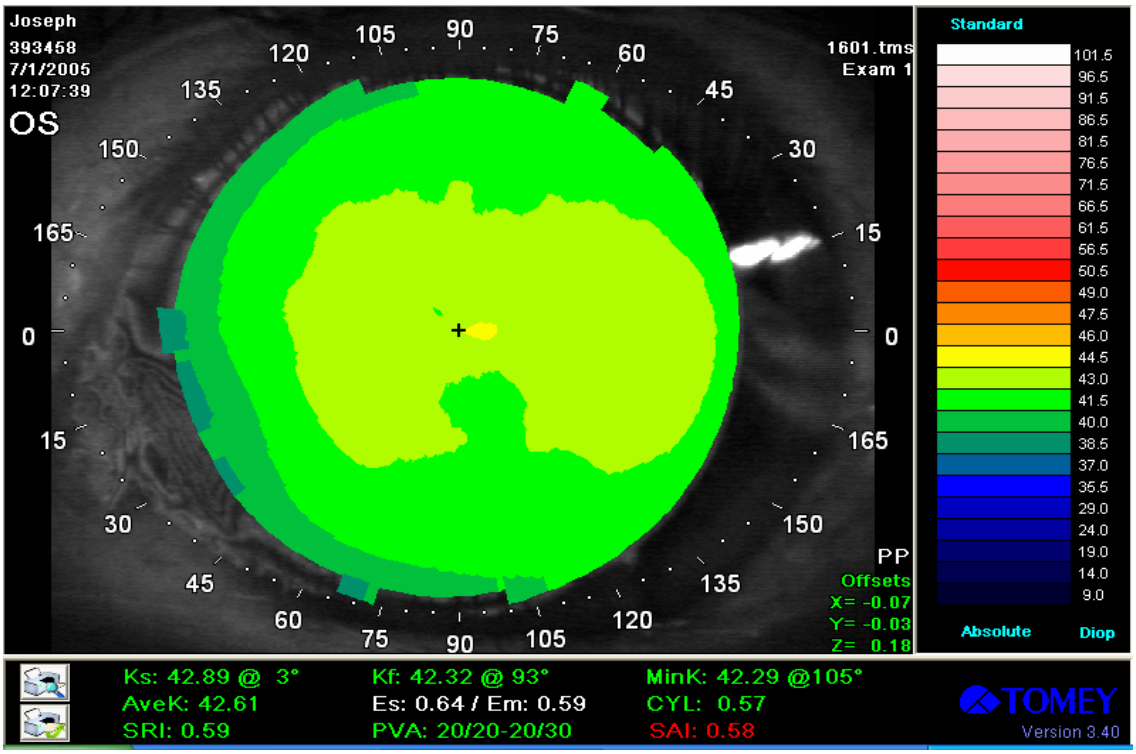


POSTOPERATIVE TOPOGRAPHY

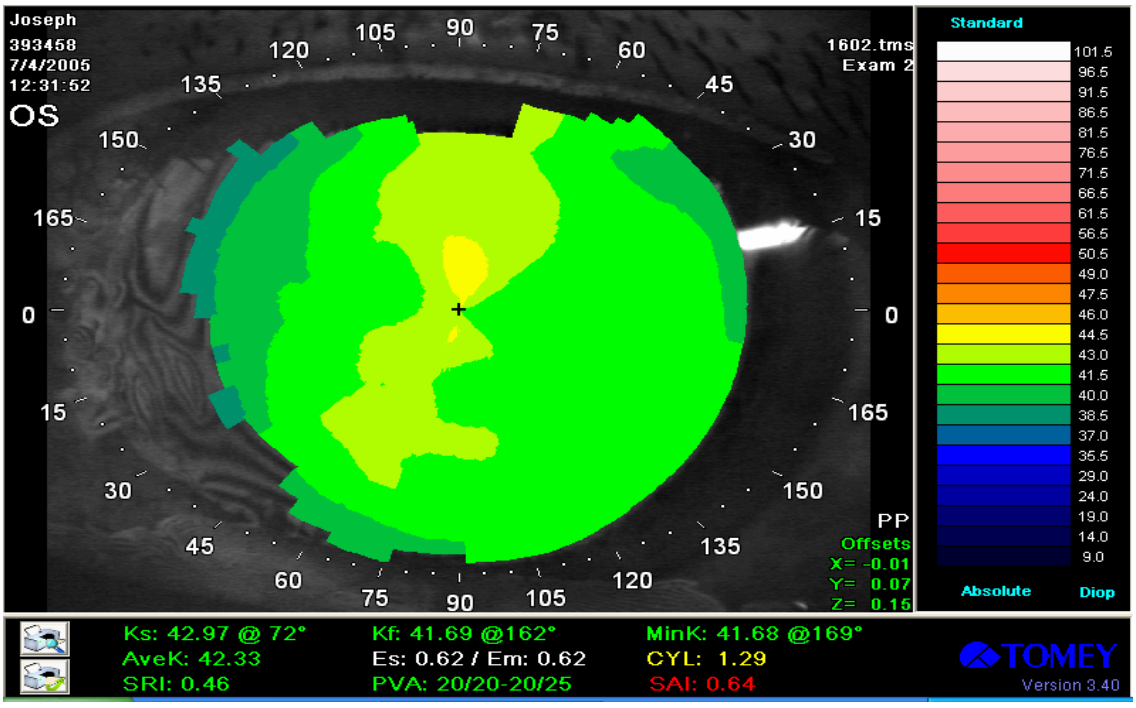


Group B (with single radial anchoring suture) Eye showing steepening towards the sutured wound that is with the rule type of astigmatism postoperatively.

PREOPERATIVE TOPOGRAPHY



POSTOPERATIVE TOPOGRAPHY



SUMMARY

Key Words:

Radial Anchoring Suture

Corneoscleral Tunnel Incision- Scleral pocket incision

Self sealing cataract incision

No stitch cataract surgery

Surgically Induced Astigmatism

This study was performed to compare the **early postoperative surgically induced astigmatism in two small groups of patients who had manual small incision cataract extraction & PCIOL implantation through potentially Self sealing 6mm sclero corneal tunnel incision, using Topographic Modeling System.**

In one group of 25 cases (Group A),incision was left unsutured.

In second group of 25 cases (Group B), the incision was closed with a single radial anchoring suture .

Ophthalmic surgeons have long paid special attention to early changes in corneal astigmatism following cataract surgery. This is because **alterations in the early period are primarily attributed to the surgical procedures and techniques.**

Many studies of the changes in the corneal astigmatism have looked at central keratometry. Few have looked at the overall alteration in corneal curvature.

In the present study, we therefore focus on the corneal topographic changes which cover the whole corneal curvature precisely in the early postoperative period .The early changes in the corneal topography can provide valuable information for improving surgical procedures and techniques.

The results of this study indicate that, when these data were analyzed by vector method of Jaffe & Clayman, little change from presurgical astigmatism was noted after surgery in either group.

The mean induced cylinder was,

0.706 Dioptre for the sutureless Group A

0.992 Dioptre for the sutured Group B, which is **less than 1 Dioptre**

In case of preexisting significant cylinder, placement of tunnel incision at the steeper meridian causes some amount of decrease in postoperative cylinder by causing flattening in the meridian that intersects the incision only in no stitch group eyes.

Only the Group B with radial anchoring suture demonstrated mainly With the rule astigmatic change in the early postoperative period. In Group A , No Stitch Group, there is net tendency mainly towards Against the rule astigmatic change.

There were no cases with wound leakage noted. No cases developed postoperative endophthalmitis or iris prolapse. Two cases in each group had minimal striate keratopathy. With topical corticosteroid eye drops in titrated dose, the striate keratopathy were cleared subsequently.

Though mean induced cylinder in Sutured eyes (0.992) was little greater than No Stitch Group A (0.706), the differences in amplitude of induced cylinders between sutured and sutureless groups were not found to be statistically significant.

I am following these patients to assess the long term topographic astigmatic changes.

ABSTRACT

The eyes with single radial anchoring suture tied over sclerocorneal tunnel incision demonstrated mainly **With The Rule Type of astigmatism** in early postoperative period, that is **steepening in the meridian that intersects the incision.**

The eyes with sclero-corneal tunnel incision left without suture demonstrated mainly **Against The Rule type of astigmatism** in early postoperative period, that is **flattening in the meridian that intersects the incision.**

Both the Groups with sclero-corneal tunnel incision showed a little induced astigmatism with Mean <1 Dioptre. Though mean induced cylinder in sutured eyes was little greater than no stitch group, the differences in amplitude of induced cylinder between two groups were not found to be statistically significant.

In case of preexisting significant cylinder, placement of tunnel incision at the steeper meridian causes some amount of decrease in postoperative cylinder by causing flattening in the meridian that intersects the incision only in no stitch group eyes.

No cases developed wound leaks or iris prolapse or postoperative endophthalmitis. **The eyes left without suture demonstrated physical stability as did those eyes with suture closure.**

Thus we finally arrived at a conclusion that, properly performed No Stitch Corneoscleral valve incisions give rise to no postoperative complications like would leaks or postoperative iris prolapse and give rise to minimal induced astigmatism, the amplitude of cylinder being indistinguishable from sutured incision. I am following the patients to assess the long term topographic astigmatic changes.

PART – 3

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PROFORMA

Case No:

IP.No/OP No:

Name: Age / Sex:

Address:

Date of Admission:

Date of Surgery:

Date of Discharge:

Presenting Complaints:

Defective Vision: RE / LE – Duration

History of Present illness

Past History:

H/o – Refractive Error

H/o – Presbyopic Correction

H/o – Previous Ocular surgery

H/o – Diabetes / Hypertension / TB

Family History :

Personal History:

General Examination:

Local Examination:

Head Posture:

Facial Symmetry

Visual Axes

Examination of the Eye by Slit Lamp:

RE LE

Lids and Adnexas:

Conjunctiva:

Cornea:

Anterior Chamber:

Iris:

Pupil:

Lens:

Vision:

Distance:

Near:

Without glasses:

With glasses:

With pinhole:

Tension (mm of Hg):

Fundus:

Investigations:

Patency of Nasolacrimal Duct

Fasting Blood Sugar

Albumin

Urine

Sugar

Blood Pressure:

Ascan – RE/LE

Keratometric reading RE/LE

Corneal Topography using TMS

Diagnosis

Medical Treatment

Surgical Treatment

Operative Notes:

Configuration of Corneoscleral section:

Whether suture placed or not- Group A or Group B

Type of suture applied

Complications – intraoperative

On discharge

SLE : Any Complications - Treatment given

Postoperative Vision

Postoperative Corneal Topography – Day 2

Net Surgically induced astigmatism

By vector method of Jaffe :

By simple subtraction method:

Axis of surgically induced cylinder:

Follow up:

Vision Corneal Topography Refraction

LIST OF SURGERIES PERFORMED

S.No.	Name	Age/Sex	IP/OP. No.	RE/LE	Diagnosis	Surgery Done	
1	Gurumoorthi	55 M	388846	LE	Mature Cataract	ECCE with PCIOL	
2	Venkatama	65 F	392367	RE	Hypermature Cataract	ECCE with PCIOL	
3	Saroja	56 F	392975	RE	Immature Cataract	ECCE with PCIOL	
4	Kuppan	52 M	393187	LE	Immature Cataract	SICS with PCIOL	
5	Pachaiyappan	68 M	393435	RE	Immature Cataract	SICS with PCIOL	
6	Babyammal	60 F	394157	LE	Immature Cataract	SICS with PCIOL	
7	Lalitha	52 F	394818	RE	Immature Cataract	SICS with PCIOL	
8	Suseela	50 F	394160	RE	Traumatic Cataract	ECCE with PI	
9	Valli	20 F	69204	RE	Chalazion	I and C	
10	Kalaiyarasi	29 F	69276	LE	Nasal Pterygium	Pterygium Excision	
11	Bakiyam	32 F	7048	LE	Lid Tear	Lid Tear Suturing	
12	Balaraj	27 M	32062	RE	Rupture Globe	Scleral Tear Suturing	
13	Rathina	50 M	8149	RE	Corneal Tear	Corneal Tear Suturing	
14	Ramesh	22 M	386941	RE	Panophthalmitis	Evisceration	
15	Ramdass	47 M	392774	LE	Fungal Corneal ulcer	TKP	
16	Pichandi	40 M	396669	RE	Mixed Corneal ulcer	TKP	
17	Rajan	70 M	392284	LE	Absolute Glaucoma	Trabeculetcomy	
18	Alamelu	51 F	49490	RE	Chronic Dacryocytitis	DCT	
19	Kuppammal	51 F	397488	LE	Chronic Dacryocytitis	DCT	
20	Babu	60 M	392764	RE	Corneal ulcer with facial palsy	Tarsorraphy	

LIST OF ABBREVIATIONS

RE – Right Eye

LE – Left Eye

ECCE – Extra Capsular Cataract Extraction

PCIOL – Posterior Chamber Intraocular Lens

SICS – Small Incision Cataract Surgery

DCT – Dacryo Cystectomy

TKP – Therapeutic Keratoplasty

I AND C – Incision and Curettage

WTR – With The Rule type of Astigmatism

ATR – Against The Rule type of Astigmatism

OBLIQUE – Oblique type of Astigmatism

KEY TO MASTER CHART

M – Male

F – Female

RE – Right Eye

LE – Left Eye

D – Dioptre

Cyl Pre – Preoperative plus cylinder in Dioptres

Axis Pre – Axis of Preoperative cylinder

Cyl Post – Postoperative plus cylinder in Dioptres

Axis Post – Axis of Postoperative cylinder

Cyl S – Surgically induced cylinder found by simple subtraction method without regard to axis.

Cyl Induced – Surgically induced cylinder in dioptres found by vector method of Jaffe. By this method all induced cylinder has a positive value.

Axis Induced – Axis of surgically induced cylinder

W – With the rule astigmatism

A – Against the rule astigmatism

O – Oblique axis of cylinder

GROUP B WITH SINGLE RADIAL ANCHORING SUTURE

S.No.	Name	I.P.No.	Age/Sex	Cyl Pre	Axis Pre	Cyl Post	Axis Post	Cylinder Induced	By vector method of Jaffe	
				(D)		(D)		By Simple	Cyl Induced	Axis Induced
								Subraction Method (D)		
								Cyl S		
1	Gnanambal	393006	65F	2.24	41º (O)	2.89	101º (w)	0.65	3.2D	80º(W)
2	Natesan	392979	60M	2.47	172º(A)	2.86	6º (A)	0.39	1.4D	35º(O)
3	Purushothaman	393200	65M	0.42	0º(A)	0.3	80º (w)	-0.12	0.4D	70º(W)
4	Thittiammal	393428	62F	0.51	29º (O)	1.4	101º(w)	0.89	1.8D	106º(W)
5	Joseph	393458	56M	0.57	3º(A)	1.29	72º(W)	0.72	1.6D	77°(W)
6	Damodaran	394136	65M	1.68	167º(A)	1.54	148º (O)	0.14	1.2D	110º(W)
7	Rajendren	394130	60M	0.82	42º(O)	2.37	83º (W)	1.55	2.3D	93º(W)
8	Lailabeevee	394908	62F	1.04	0º(A)	0.6	10º (A)	0.44	0.5D	78º(W)
9	Balammal	394896	58F	0.42	138º(O)	2.39	89º (W)	1.97	2.3D	84º(W)
10	Ponnuraj	394882	59M	0.3	90º(W)	0.5	80º (w)	0.2	0.3D	67°(W)
11	Kannammal	395136	59F	0.36	97º(W)	0.58	77º(W)	0.22	0.3D	58º(O)
12	Baby	395425	60F	3.14	173º(A)	3.09	173º(A)	0.05	0.05D	113º(O)
13	Pankajammal	4E+06	62F	0.74	6º(A)	0.22	173º (A)	0.52	0.5D	102º(W)
14	Gnanambal	395847	57F	0.1	86º(W)	0.8	110º (W)	0.7	0.7D	104°(W)
15	Rajeswari	395855	59F	0.74	4º(A)	0.11	90º (W)	0.63	0.7D	91º(W)
16	Habib Fathima	395855	59F	0.43	60º(O)	2.36	104º (W)	1.93	2.3D	109º(W)
17	Sundereswaran	395866	60M	0.99	0º(A)	1.04	3º(A)	0.05	0.5D	9º(A)
18	Aruputham	395875	57F	0.25	90º(W)	0.75	90º(W)	0.05	0.5D	90º(W)
19	Suseela	396107	56F	0.72	170º(A)	0.9	112º (W)	0.18	0.9D	46°(O)
20	Esther	396304	59F	0.5	90º(W)	0.75	100º (W)	0.25	1.2D	105º(W)
21	Moorthi	396586	64M	0.6	14º(A)	0.1	0º (A)	0.5	0.5D	109º(W)
22	Munisekar	396603	61M	0.8	12º(A)	0.7	173º (A)	0.1	0.5D	141º(O)
23	Saroja	396615	62F	0.25	180º(A)	0.5	180º(A)	0.25	0.25D	180º(A)
24	Raniammal	396304	64F	0.78	4º(A)	0.1	70º(W)	0.68	0.8D	90°(W)
25	Adhimoolam	396294	65M	0.9	10º(A)	0.9	112º (O)	0.1	0.1D	30°(O)

GROUP A - (NO SUTURE GROUP)

S.No.	Name	I.P.No.	Age/Sex	Eye	Cyl Pre (D)	Axis Pre	Cyl Post (D)	Axis Post	Cyl S (D)	By vector method of Jaffe	
										Cyl Induced	Axis Induced
1	Gangayee	393102	65F	RE	1.68	59º (O)	1.78	26º (O)	0.10D	1.6D	178º(A)
2	Kalyani	393197	60F	RE	0.6	136º(O)	0.42	0º (A)	0.18D	0.7D	30º(O)
3	Manonman	393432	64F	RE	0.21	4º(A)	0.59	4º (A)	0.38D	0.38D	4º(A)
4	Govindham	393439	55F	RE	0.46	46º (O)	1.34	114º(O)	0.88D	1.6D	120º(O)
5	Saraswathi	393621	60F	LE	0.64	101º(W)	0.98	128º(O)	0.38D	0.38D	4°(A)
6	Rajan	393890	60F	RE	1.39	4º(A)	1.31	129º (O)	0.08D	0.5D	55º(O)
7	Kesavan	393888	55M	RE	0.34	98º(O)	0.37	162º (A)	0.03D	1.0D	7º(A)
8	Vasanthak	393871	60F	RE	0.42	8º(A)	0.79	10º (A)	0.37D	0.4D	15º(A)
9	Perumal	394130	52M	LE	1.79	177º(A)	1.13	38º (W)	0.66D	2.8D	66º(O)
10	Sakuntala	394138	59F	LE	1.56	35º(O)	1.67	28º (w)	0.11D	0.8D	176°(A)
11	Bhuvanesv	394874	55F	RE	0.9	90º(W)	1.2	80º(W)	0.30D	0.4D	36º(O)
12	Chelliamm	395147	55F	LE	1.4	96º(W)	0.76	95º(W)	0.64D	0.7D	13º(A)
13	Saithunbee	395123	54F	LE	0.43	3º(A)	0.8	140º (O)	0.37D	0.4D	27º(O)
14	Saravanan	395158	64M	RE	0.88	78º(W)	0.21	140º (O)	0.67D	0.9D	161°(A)
15	Parvatham	395298	54F	RE	0.73	41º(0)	0.56	30º (O)	017D	0.6D	102º(W)
16	Kodipavun	395632	60F	LE	0.6	10º(A)	0.8	20º (A)	0.20D	0.2D	25º(O)
17	Seetha	395631	55F	LE	0.19	44º(O)	0.31	38º(O)	0.19D	0.15D	27º(O)
18	Raheem	39502	56M	LE	1.69	7º(A)	1.51	6º(A)	0.18D	0.1D	115º(W)
19	Thiruvasag	395451	60M	LE	0.5	90º(W)	0.6	180º (A)	0.10D	0.7D	161°(A)
20	Lakshmi	395860	54F	RE	0.34	180º(A)	0.9	174º (A)	0.56D	0.6D	172º(A)
21	Kadirselvi	396103	60F	RE	0.86	90º(W)	0.78	94º (W)	0.08D	0.2D	25º(O)
22	Narayanan	396108	60F	RE	1.15	104º(W)	0.99	180º (A)	0.16D	0.5D	45º(O)
23	Savathri	396320	52F	RE	0.86	4º(A)	0.99	12º(A)	0.13D	0.3D	44º(O)

24	Periyanaya	396316	60M	RE	0.41	180º(A)	0.84	12º(A)	0.43D	0.4D	20°(A)
25	Jamuna	396311	54F	RE	0.78	144º(O)	0.9	4º (A)	0.12D	1.1D	25°(O)